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San Joaquin Co - Safety

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

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FOR SAN JOAQUIN COUNTY
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JANUARY 1974

Orientation Folder

FLOODS

FLOODS

Northeast
Stream
Group

Stockton, California

January 1974

FLOODS

in the NORTHEAST STREAM GROUP

The Northeast Stream Group comprises the Calaveras River and Bear Creek stream systems in the vicinity of Stockton. The streams and streamways involved are the Calaveras River; Mormon Slough; the Stockton Diverting Canal; Bear Creek; Mosher Creek; Mosher Creek Diversion; and Paddy, Middle Paddy, and South Paddy Creeks in the area generally bounded by the foothill line on the east, Highway 99 on the west, the Mokelumne River drainage on the north, and the Duck Creek drainage on the south. Flood plain areas along these waterways have been damaged by large floods in the past; and studies made for a flood plain information (FPI) report show that widespread flooding could occur in the future, even though flood control facilities have been provided on some of the streams studied.

The FPI report presents facts on the flood potential and the flood hazard along the streams and streamways of the Northeast Group. It includes information on past floods, and maps, drawings, and photographs that illustrate the extent and severity of certain future floods that have been designated as the Intermediate Regional Flood (IRF) and the Standard Project Flood (SPF). An IRF is a large flood expected to occur about once in 100 years on the average although it could occur in any given year. By way of contrast, existing flood control improvements provide, as a minimum, protection against floods expected to occur about once in 50-60 years on the long-term average. A higher degree of protection is afforded some parts of the study area. An SPF is an extremely large flood, but one that can reasonably be expected to occur in the future. It would be a much greater flood than an IRF, but one that could still occur in any particular year.

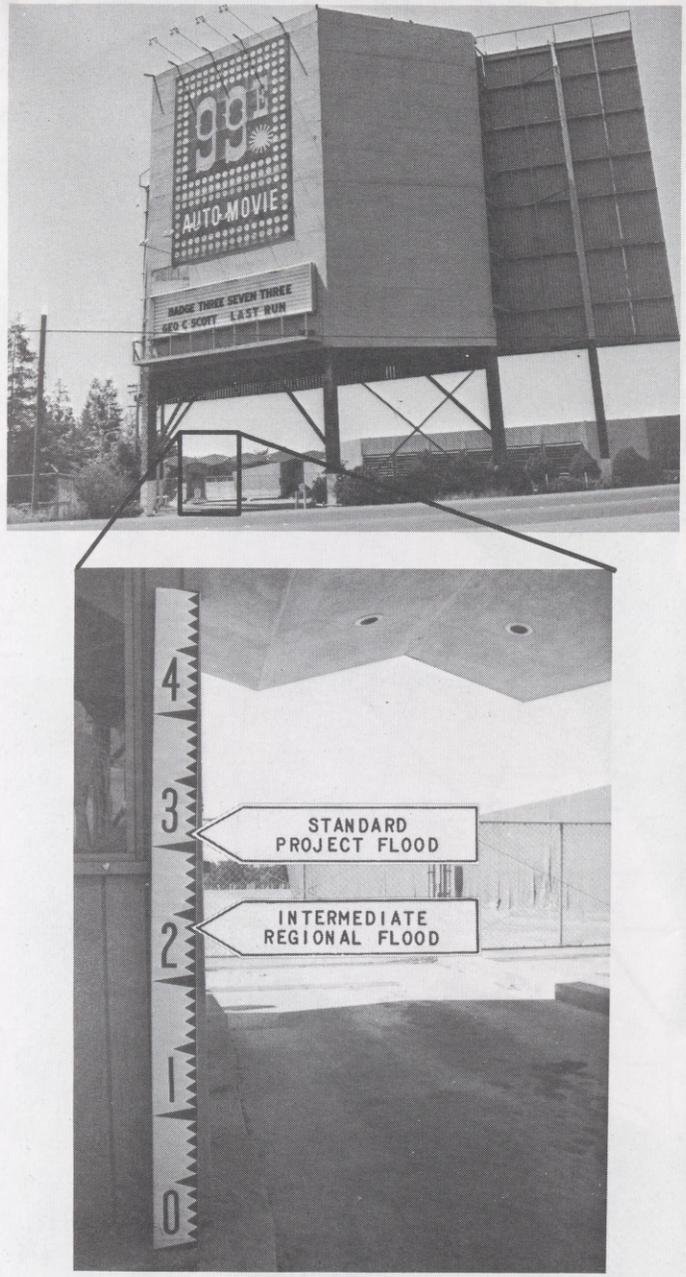
The purpose of FPI reports is to provide a basis for managing the use of flood prone lands in such a way that flood hazards and damage during future floods are minimized or eliminated.

Calaveras River floodwater northerly of the Highway 99 crossing of the Diverting Canal, December 1955.

ACTION is needed

San Joaquin County has acted to discourage discontiguous urban patterns and encourage, through tax benefits, the preservation of agricultural land, public open space, scenic areas, and wildlife habitat. In general, the area studied for the FPI report comprises agricultural preserve lands on the east side of Alpine Road and non-preserve lands on the west side. Therefore, flood plain areas, particularly along and in the vicinity of Highway 99 will continue to be converted from their natural state and agricultural uses to residential and commercial uses. Also, residential development is expected northerly and westerly of Linden and isolated rural residences will undoubtedly be built, particularly along the Calaveras River. Accordingly, flood hazards and flood damage are subject to increase unless preventive or corrective actions are taken.

Effective regulatory measures such as flood plain zoning, subdivision regulations, and building codes can be adopted to prevent or minimize increases in flood damage. Flood insurance can help to compensate for flood losses. Flood proofing can prevent future damage to existing structures subject to flooding, and flood control works to modify flood patterns can also be part of a long range solution. Flood plain regulations, which are becoming more and more acceptable as a practical approach to flood damage reduction, encourage the highest and best use of flood prone areas.

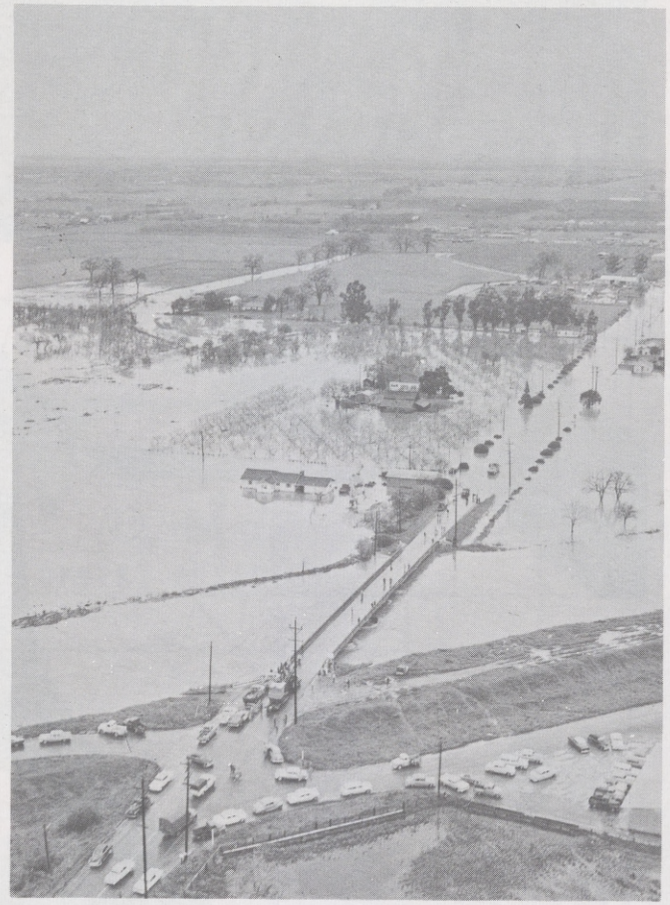


Future flood heights in an overflow area near the junction of the Calaveras River and the Stockton Diverting Canal.

This folder has been prepared for San Joaquin County by the Sacramento District, U.S. Army Corps of Engineers. It is partially based on data in the report entitled "Flood Plain Information, Northeast Stream Group, Stockton, California." Copies of the report and this folder are available upon request from San Joaquin County Planning Department.

COVER PHOTOGRAPH – Flooding in the vicinity of the Highway 26 crossing of the Stockton Diverting Canal, April 1958. (Stockton Record Photo)

FLOODS



Northeast Stream Group

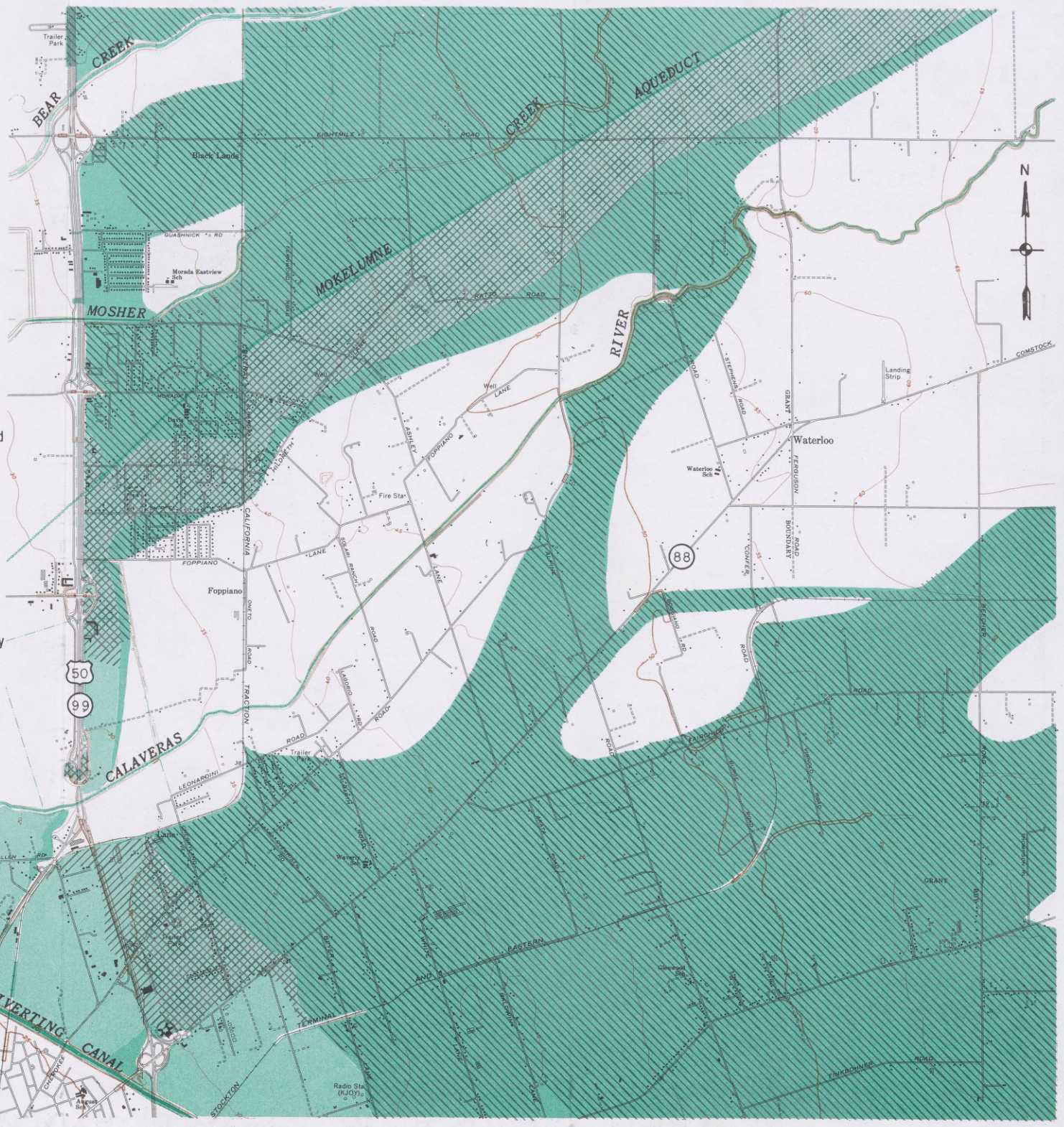
Stockton, California

January 1974

FLOOD PATTERNS

Northeast Stream Group

STOCKTON, CALIFORNIA



Maps and other illustrations for the entire study area (the flood plains of the Calaveras River distributary system and Bear Creek and its tributary system generally from Highway 99 easterly to the foothill line) are contained in the FPI report.

LEGEND

Overflow Limits

- Low Water Channel
- Intermediate Regional Flood
- Standard Project Flood

Area Subject to Sheet Flow

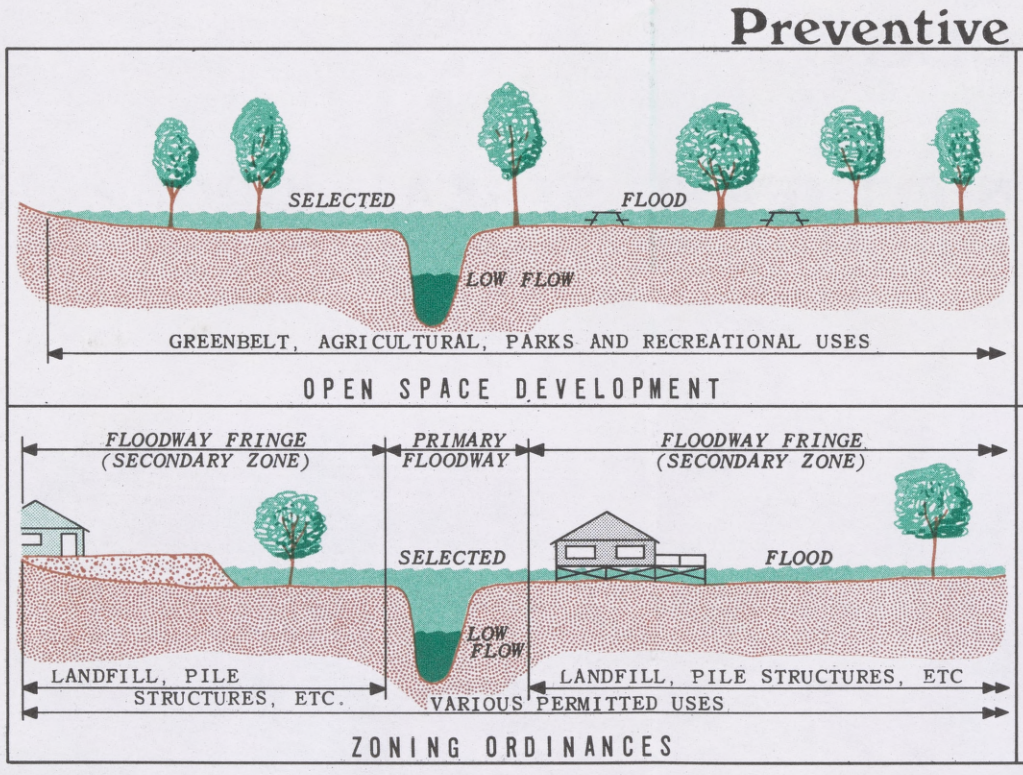
- Standard Project Flood Only
- Standard Project and Intermediate Regional Floods
- Intermediate Regional Flood Only

(Limits of Flooding are Approximate)

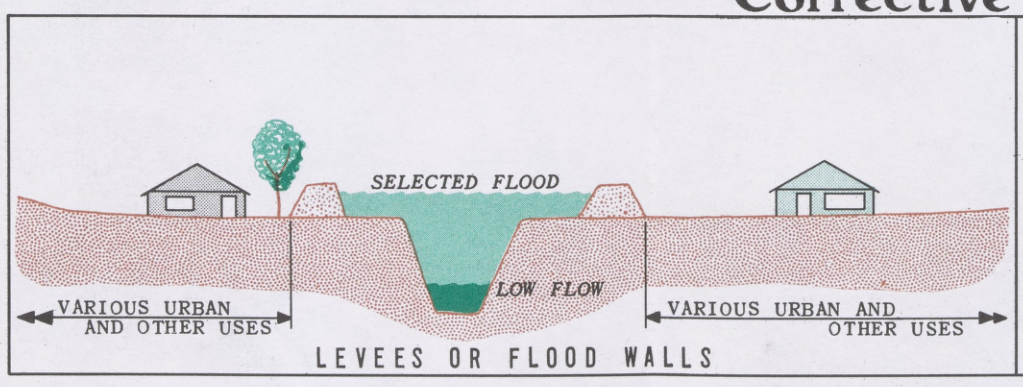
SCALE IN FEET
2000 0 2000 4000 6000
CONTOUR INTERVAL 5 FEET

FLOOD PLAIN MANAGEMENT MEASURES USABLE FOR THE REDUCTION OF FLOOD DAMAGE

Preventive Measures



Corrective Measures



Preventive measures reduce vulnerability to flood damage and provide for greater flexibility in land use management, often at minor cost and with little adverse effect on the environment. Preventive measures other than those illustrated above include subdivision regulations, building codes, health regulations, tax adjustments, and warning signs. Corrective measures are often required to alleviate existing flood problems and forestall future problems. Two types of corrective measures are illustrated above. Others include dams and reservoirs, watershed treatment, permanent flood plain evacuation, flood forecasting, and urban redevelopment. Preventive and corrective measures may be used by themselves or in varying combinations to meet the specific needs of a particular flood prone area. Public support is necessary to obtain needed flood damage reduction through flood plain management measures.

Stockton, California

Northeast Stream Group

January 1974

FLOODS

in the NORTHEAST STREAM GROUP

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Calaveras River floodwater northerly of the Highway 99 crossing of the Diverting Canal, December 1955.

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COVER PHOTOGRAPH – Flooding in the vicinity of the Highway 26 crossing of the Stockton Diverting Canal, April 1958. (Stockton Record Photo)

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Future flood heights in an overflow area near the junction of the Calaveras River and the Stockton Diverting Canal.

STREAM GROUP

northerly of the Highway
ng Canal, December 1955.

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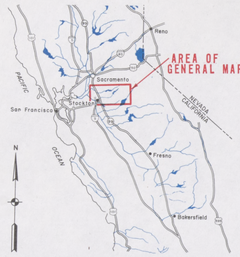
Cover photograph: Floodwater on the north side of the Stockton Diverting Canal, February 1938. (Stockton Record photograph.)

+ N O T E +

Unless otherwise indicated, all photographs in this report were taken by the Corps of Engineers personnel.



VICINITY MAP

SCALE IN MILES

50 0 50 100 150

LEGEND

- County Boundary
- Drainage Basin Boundary
- Foothill Line
- Populated Area
- (5) Interstate Highway
- (88) U S Highway
- (99) State Highway
- ▲2 Stream Gage (See table 3 for identification)
- ●5 Precipitation Gage (See table 4 for identification)
- Study Limits

SCALE IN MILES

5 0 5

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

GENERAL MAP

JANUARY 1974

PLATE 1

PREFACE

The area covered by this report is subject to flooding from streams of the Calaveras River and Bear Creek systems. This is the first of four reports that will ultimately cover the entire greater Stockton area. That is, from about Lodi on the north to Manteca on the south, and from about the foothill line on the east to the San Joaquin River on the west. For purposes of the overall study, the streams have been grouped and the area divided into northeast, southeast, southwest, and northwest sectors. The northeast sector generally extends from State Highway 99 easterly to the foothill line, and from the Mokelumne River drainage on the north to the Duck Creek drainage on the south. Properties along the streams and streamways under study are primarily agricultural and have been moderately damaged in the past, especially in 1955 and 1958. New Hogan Dam and Lake, a multiple purpose project on the Calaveras River was completed by the Corps of Engineers in 1964. Other Corps of Engineers flood control facilities providing protection in the study area comprise improvements along channels of the Calaveras River distributary system, which are necessary to efficient operation of New Hogan Lake, and channel improvement work and levee construction along channels of the Bear Creek system. Flood control improvements comprising levee construction, channel improvement work, and a diversion facility have been provided by the Soil Conservation Service along Mosher Creek, a tributary stream in the Bear Creek system. Existing facilities for flood damage reduction are designed to provide a moderate degree of protection to the city of Stockton and its surrounding area. Floods larger than those that have occurred in the past and larger than those for which existing projects were designed can occur in the future. Accordingly, flooding and flood damage can still be expected.

This report was prepared because knowledge of potential flooding is important in the land-use planning of flood plains. It contains information on past floods, and maps, profiles, and cross sections that indicate the approximate extent and depth of inundation from large floods that can reasonably be expected to occur in the future. For purposes of this report, these future floods have been designated as the Intermediate Regional and Standard Project Floods. The report provides the city and county a basis for study and planning for optimum use and development of flood prone areas through zoning and subdivision regulations, construction of flood control projects, or by a combination of these and other approaches to reducing flood hazards and flood damage. Information contained in the report would also be useful in programs dealing with ecological and environmental aspects of the study area and its land-use role as part of its surroundings. Recommendations or plans for solution of continuing flood problems in the study area are not included in this report. Neither does it extend any Federal authority over zoning or other regulation of flood plain use.

This report was prepared at the request of the San Joaquin County Board of Supervisors, with the indorsement of the California Department of Water Resources, under the continuing authority provided the Corps of Engineers in Section 206 of the 1960 Flood Control Act (Public Law 86-645), as amended.

The Sacramento District gratefully acknowledges the assistance and cooperation of the U.S. Soil Conservation Service, San Joaquin County, the California Division of Highways (Bridge Department), the Lodi City Library, the Stockton Record, and others who aided directly or indirectly in the preparation of this report.

The Planning Department of San Joaquin County will make the information in this report available to all interested agencies and individuals. Copies of the report and information on its use are available from that agency. The Sacramento District of the Corps of Engineers

will, upon request, provide technical assistance to local, State, and Federal agencies in the interpretation and use of data presented herein, and will provide other available flood data related thereto.

BACKGROUND INFORMATION

SETTLEMENT

Permanent settlement of the Stockton area began as early as 1844 and land for agricultural purposes was taken up along the Calaveras River as early as 1846, but it was not until the gold rush that important development took place. During that period, Stockton became a principal supply center and a crossroads of land and water transportation for travelers and freight enroute to the southern mines. Agricultural activities, particularly stock raising and wheat production, began to develop in adjoining areas to support the growing city and provide hides for export. Linden, which began as a stop on the Mokelumne Hill Road during the gold rush, was laid out in 1862 as the center of a highly productive grain growing region. Subsequently, the potential of the Calaveras River-Bear Creek area for livestock production and dry farmed wheat, and its proximity to water and rail transportation, were basic to its continued occupation and development. Linden remained the center of a wheat growing region until about 1900 when development of irrigation systems providing large and dependable supplies of water stimulated change to more diversified agriculture. The particularly favorable soils and climate for fruit and nut orchards in the Linden area, and the existing road for transportation of products, resulted in the establishment of extensive orchards on former wheat land. Ultimately, a railroad was extended into the area to support the orchard industry. Following the end of World War II, the need for housing resulted in the development of rural residential areas and associated commercial establishments on flood prone agricultural lands in the western sector of the study area. However, due

to the rural nature of the study area and greater vulnerability to floods in the recent past, extensive urbanization did not take place in the post war years. Most of the area is devoted to agricultural uses and, with the exception of continuing conversion of small amounts of agricultural land to residential, commercial, and light industrial uses, it is expected that land use in the study area will not radically change in the next 25-30 years. Further, lands in San Joaquin County have been brought under the California Land Conservation Act of 1965 and other applicable laws that, through tax relief, encourage the preservation of agricultural land, public open space, scenic areas, and wildlife habitat, and discourage discontiguous urban development patterns. In general, the study area comprises agricultural preserve lands on the east side of Alpine Road and non-preserve lands on the west side.

THE STREAMS AND THEIR VALLEYS

The study area for this report comprises the flood plains and immediately adjacent areas along nine streams and waterways in San Joaquin County northeast of Stockton (see Plate 1). The streams and waterways covered are elements of either the Calaveras River system or the Bear Creek system, which drain adjoining basins.[(a)] Pertinent data on stream courses and waterways are shown in Table 1.

(a) *The Bear Creek and Calaveras River flood plains are related in that, historically, the southern portion of the Bear Creek flood plain was also within the northern portion of the Calaveras River flood plain and subject to flooding from a major Calaveras River flood. Also, exchange of floodwaters may occur between Mosher Creek and the Calaveras River in the upper portion of the study area.*

TABLE 1

STREAMS AND WATERWAYS UNDER STUDY

Name	Identity	Approximate Limits of Study		Approximate Length in Study Area miles
		From:	Upstream to:	
Calaveras River	San Joaquin River tributary	Mouth, Stockton Diverting Canal	Escalon-Bellota Road	20
Mormon Slough	Calaveras River distributary	Head, Stockton Diverting Canal	Escalon-Bellota Road	13
Stockton Diverting Canal	Flood control channel, Calaveras River system	Calaveras River	Head of canal at Mormon Slough	5
Bear Creek	San Joaquin River tributary *(a)*	State Highway 99	Jack Tone Road	9
Mosher Creek and Mosher Creek Diversion	Bear Creek tributary	Lower end of diversion	Jack Tone Road	3
Lower Mosher Creek	Bear Creek tributary	State Highway 99	Head of Mosher Creek Diversion	4
Paddy Creek	Bear Creek tributary	Mouth (Bear Creek)	Jack Tone Road	3
Middle Paddy Creek	Paddy Creek tributary	Mouth (Paddy Creek)	Jack Tone Road	1
South Paddy Creek	Paddy Creek tributary	Mouth (Paddy Creek)	Jack Tone Road	1

(a) Via connecting sloughs.

As may be seen from Plate 1 and Table 1, the streams and waterways of the Northeast Stream Group form fairly complex tributary and distributary patterns. However, both principal streams under study are tributary to the San Joaquin River; the Calaveras River joining that stream directly, and Bear Creek flowing to the San Joaquin indirectly via connecting sloughs.

In the study area, the Calaveras River is distributary in nature, the stream dividing into north and south branches at Bellota, where a division of flow structure has been provided. The northern branch, Calaveras River, flows westerly across the valley floor to join the San Joaquin River just west of Stockton. Very little flow enters this branch except during the summer when diversions are made for irrigation and ground-water replenishment. The southern branch, Mormon Slough, carries most of the flow. Its course extends in a general southwesterly direction from Bellota to central Stockton where the slough joins Upper Stockton Channel, the terminus of the Stockton Deep Water Ship Channel. East of Stockton, however, a diverting canal conveys flow in the slough to the Calaveras River, and, under most conditions, blocks flow into the lower reach.

Bear Creek is also a distributary stream in the study area, historically dividing into north and south branches about 3 miles downstream from Jack Tone Road. These channels traverse the valley floor for about 12 miles southwesterly from the point of division to discharge into Disappointment Slough, which connects with the San Joaquin River. Discharge from the stream system may also reach the river by way of Rindge Cut and Fourteenmile Slough.

Flow to North Branch Bear Creek, which is also known as Pixley Slough, is now blocked by a flood control levee. South Branch Bear Creek, which is generally known simply as Bear Creek, is joined by two tributaries, Paddy and Mosher Creeks, in the study area. A diversion channel carries flows from the upper Mosher Creek drainage to Bear Creek at a point about 3 miles east of Highway 99.

The watershed of the study area is situated in San Joaquin and Calaveras Counties. It is bounded by the Mokelumne River Basin on the north and by the Duck Creek and Stanislaus River Basins on the south and east. Elevations in the Calaveras River drainage vary from about 6,000 feet in the highest headwater areas to about 30 feet in the lower part of the study area. Bear Creek is a low elevation stream, elevations in the tributary drainage area varying from less than 1,000 feet in the headwater areas to about 35 feet in the lower part of the study area. Native vegetation in the tributary areas varies from light stands of deciduous trees, high brush, and ground cover of common wild grasses in the lower elevations to moderately dense stands of conifers in the high elevations of the Calaveras River drainage. Native vegetation on the valley floor has been drastically modified by agricultural operations.

Climate of the study area and its tributary drainage is classified as dry sub-humid and is characterized by only two well defined seasons-long hot summers with practically no rain, and short mild winters with frequent rain and some snow in the headwater areas of the Calaveras River. Normal annual precipitation increases in an easterly direction over the basins and ranges from about 15 inches in valley floor areas to 50 inches in the upper Calaveras River Basin. Normal annual precipitation averages about 33 inches on the area above New Hogan Lake. The Calaveras River extends into the snowfall area, but only 3 square miles of its drainage area lie above 5,000 feet, where wintertime precipitation usually occurs as snow and a snowpack accumulates.

Temperatures range from highs of about 105 degrees during summer to lows near freezing during winter. However, extremes have ranged from 115 degrees in summer to 10 degrees in winter. In the study area, temperature may drop below freezing for a few hours of several consecutive days, but extended periods of subfreezing weather do not occur.

The study area and its tributary drainage areas total about 700 square miles as indicated in Table 2, page 6.

TABLE 2

STUDY AREA AND TRIBUTARY DRAINAGE

Stream and Location	Approximate Area sq. mi.
Calaveras River System:	
At Bellota	473
Valley floor area	124
At mouth	597
Bear Creek System:	
Paddy Creek at mouth	28
Mosher Creek at mouth of diversion	9
Bear Creek:	
At Jack Tone Road	48
At Highway 99	85
Valley floor area (local drainage)	23
Total at lower limit of study area	108

In general, the channels of the streams under study are well defined and large enough to carry the flows of most large floods. Levees have been built along the lower reaches of most of these streams. However, large floods that exceed channel capacities, break out-of-channel upstream from levees, or overtop levees can be expected to occur. Numerous swales and overflow channels carry Bear Creek floodwater to many parts of the study area.

DEVELOPMENTS IN THE FLOOD PLAIN

Lands in the study area are very productive and extensively cultivated. They are used primarily for orchards, vineyards, and irrigated row and field crops. Some areas are devoted to stock raising and dairying, but these activities are much less important than crop production, particularly peaches, cherries, and walnuts. Sugar beets are the most important field crop of the area. Improvements in rural flood plain

areas primarily comprise those associated with orcharding and include extensive facilities for irrigation. Commercial development is largely limited to retail establishments and recreational enterprises located near several subdivisions and numerous single-family rural residences in the western sector of the study area. Light industrial development is primarily related to farming, and consists of facilities for packing, shipping, warehousing, and transporting agricultural products, and merchandising and storing agricultural chemicals. Linden, an unincorporated community of about 800 and the shipping point for an important cherry, walnut, and peach growing region, is situated in the overflow area of the Calaveras River. At present, the population of the study area is estimated at 15,000, and is expected to increase to about 25,000 by the year 2000.(a) In general, the Bear Creek portion of the study area has less development than the Calaveras River portion.

Surface transportation facilities in the study area consist of two local railroads, a branch line of the Southern Pacific Railroad, three major highways, and a network of county roads. The study area is indirectly served by the Stockton Deep Water Ship Channel, which terminates in Stockton, and by major airlines that maintain scheduled flights to Stockton Metropolitan Airport.

The Mokelumne Aqueduct, an underground conduit that carries water for municipal and industrial uses in the service area of the East Bay Municipal Utility District, traverses the northern portion of the study area in a southwesterly direction.

With the exception of the Calaveras River and Lower Mosher Creek, the streamways under study have been leveed for flood control, or have been improved by widening and deepening. Levees to protect agricultural areas have been constructed by individual landowners along the Calaveras

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(a) *Based on California Department of Finance and San Joaquin County Planning Department projections.*

River, but these are low, discontinuous, substandard structures that afford little protection against high flows.

At present, the study area is not extensively urbanized and about 93 percent of the land remains devoted to agriculture or is vacant. Three percent of the area is residential, and about ½ of 1 percent is devoted to commercial or light industrial uses. The remaining land, about 4 percent, is taken up by road and railroad rights-of-way. In general, it is expected that land use patterns in the study area will not radically change in the next 25-30 years. Urbanization will continue at a slow rate in areas generally easterly and northerly of those already developed, and a good number of isolated rural residences will undoubtedly be built, especially along the Calaveras River. Also, a small amount of residential development ranging from low to urban density is expected to occur northerly and westerly of Linden, and some light industrial development may occur east of the Diverting Canal and south of the Southern Pacific Railroad. However, it is estimated that only an additional 2 percent of the study area will be developed to residential use, and an additional 1 percent to commercial and light industrial uses by the year 2000. The amount of agricultural or vacant land will, of course, decrease slightly (to about 90 percent of the total) by that time.

FLOOD SITUATION

SOURCES OF DATA AND RECORDS

Information relative to past floods was developed from available streamflow records, and from newspaper files, post flood reports prepared by the Corps of Engineers, and the preauthorization and design documents for existing flood control projects. Basic hydrologic data were derived from streamflow records of the gaging stations shown in Table 3. The location of each station is shown on Plate 1.

TABLE 3

STREAM GAGING STATIONS[a]

Station Number	Station Name	Period of Record	Maximum Recorded Peak Flow	
			c.f.s.	date
1	STOCKTON DIVERTING CANAL AT STOCKTON	1944-Present	11,400	Apr 1958
2	CALAVERAS RIVER NEAR STOCKTON	1948-Present	760	Jan 1965
3	MORMON SLOUGH AT BELLOTA	1948-Present	15,400	Apr 1958
4	CALAVERAS RIVER AT BELLOTA	1948-1966	1,570	Apr 1958
5	CALAVERAS RIVER AT JENNY LIND	1907-1966	50,000	Jan 1911
6	COSGROVE CREEK NEAR VALLEY SPRINGS	1929-1969	3,240	Dec 1955
7	BEAR CREEK NEAR LOCKEFORD	1930-1933 1943-Present	2,930	Apr 1958
8	BEAR CREEK NEAR LODI	1965-Present	3,300	Jan 1970

(a) Stream gage data were extracted from California Department of Water Resources publications except for Stations 5, 6, and 7, which were extracted from U.S. Geological Survey publications.

There are four precipitation stations in the drainage area directly tributary to the study reaches. Records from these stations and from seven selected stations in areas nearby were used in the basic hydrology studies for this report. Information on the stations used and the precipitation recorded during the largest flood producing storms of recent years is shown in Table 4. The location of each station is shown on Plate 1.

TABLE 4

PRECIPITATION STATIONS

Station Number	Station Name	Normal Annual Precipitation	Recorded Precipitation 21-24 Dec 1955	Recorded Precipitation 1-4 Apr 1958
			inches	inches
1	ELLIOTT	16.7	4.2	4.6
2	LODI	16.9	4.6	4.1
3	STOCKTON FIRE STA NO 4	14.2	3.9	3.8
4	STOCKTON DISPOSAL PL	13 (a)	3.4	3.7
5	STOCKTON WSO AP	12 (a)	4.6	2.9
6	OSPITAL RANCH (b)	19 (a)	(c)	(c)
7	WALLACE 1SE (b)	19.6	5.7	5.4
8	NEW HOGAN DAM (b)	23 (a)	(c)	(c)
9	CAMP PARDEE	20.7	4.9	4.5
10	SAN ANDREAS 2S (b)	26.7	9.0	6.7
11	ELECTRA POWER HOUSE	30.6	8.9	5.6

(a) Estimated.
(b) Station in drainage area directly tributary to study reaches.
(c) Station not in operation at time of storm.

There are no streamflow or precipitation stations in the study areas or tributary drainages of Mosher, Paddy, Middle Paddy, and South Paddy Creeks. Therefore, basic hydrologic and meteorologic data were synthesized from records of nearby basins of similar size and precipitation-runoff characteristics. Hydrologists made a detailed field inspection of the study area to define basin characteristics.

The topographic maps prepared for this report to show areas that would be inundated by large future floods (Plates 7-14) were based on the following U.S. Geological Survey quadrangle sheets.

Name	Edition	Name	Edition
Lockeford	1968	Valley Springs SW	1962
Lodi South	1968	Stockton West	1968
Waterloo	1968	Stockton East	1968
Linden	1968	Peters	1968

Cross sections and stream profiles were developed from the quadrangles named above, Corps of Engineers and U.S. Soil Conservation Service topographic data used in the design and construction of existing flood control projects, and topographic data furnished by San Joaquin County. Structural dimensions on bridges and culverts were furnished by San Joaquin County and the California Division of Highways (Bridge Department), or obtained by field investigation during the preparation of this report.

FLOOD SEASON AND FLOOD CHARACTERISTICS

General rainfloods can occur in the study area anytime during the period from November through April. This type of flood results from prolonged heavy rainfall over the tributary areas and is characterized by high peak flows of moderate duration. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions, or when the ground is frozen and infiltration is minimal.

Cloudburst storms, sometimes lasting as long as three hours, can occur over the drainage basins tributary to the study area anytime from late spring to early fall. These are high-intensity storms that can produce peak flows equal to or somewhat greater than those of general flood producing rainstorms in portions of the study area. Flooding from cloudbursts is characterized by high peak flows, short duration of floodflow, and small volume of runoff. Cloudburst storms

are small in areal extent and of short duration. Therefore, cloudburst storms over the Calaveras River Basin would not produce flows that would cause flooding.

The high elevation tributary area of the Calaveras River Basin subject to accumulation of snowpack is too small to generate snowmelt flooding. Snowmelt during a general rain flood producing storm series would not increase runoff significantly. Due to the low elevation of the headwater areas of Bear Creek and its tributaries, snowfall is extremely rare and there is no accumulation of snowpack.

FACTORS AFFECTING FLOODING AND ITS IMPACT

Obstructions to Floodflows.

Natural obstructions to floodflow include brush and other vegetation growing along the streambanks in floodway areas. During floods, brush growing in floodways impedes floodflows and results in backwater and increased flood heights. Brush washed out during floods and carried downstream may collect on bridges or plug culverts, thus creating a damming effect and overbank flow. As floodflow increases, masses of debris may break loose and a wall of water and debris may surge downstream until another obstruction is encountered. In general, obstructions restrict floodflows and cause overbank flows, unpredictable areas of flooding, possible destruction of or damage to bridges and culverts, and increased velocities of flow immediately downstream.

In the study area, there are 119 structures of one sort or another across the various streams and streamways. The number and location of these structures are indicated in the following table.

TABLE 5

STRUCTURES ACROSS THE STREAMS

Structure	Calaveras River	Mormon Slough	Stockton Diverting Canal	Bear Creek	Mosher Creek[a]	Lower Mosher Creek	Paddy Creek	Middle Paddy Creek	South Paddy Creek	Total
Railroad bridges	0	1	3	1	0	1	0	0	0	6
Highway and road bridges[b]	28[15]	8	8	15[6]	3[1]	7[1]	3[1]	1	2	75
Low water crossings	0	1	0	2	0	1	0	0	0	4
Diversion structures	5	11	1	4	2	3	1	1	1	29
Combination stream crossing and diversion	3[c]	0	0	0	0	0	0	0	0	3
Pipeline crossings	0	0	0	0	1	1	0	0	0	2
Total	36	21	12	22	6	13	4	2	3	119

(a) Includes Mosher Creek Diversion.
(b) Includes privately owned road bridges which are shown in [ ].
(c) Two of the structures are privately owned. One comprises a bridge owned by the county and a diversion owned by an irrigation district.

Of the foregoing stream crossings and structures, 5 railroad bridges, 58 highway and road bridges, 2 low water crossings, 17 diversions, the 3 combination stream crossing-diversion structures, and the 2 pipeline crossings are considered to be obstructive to floodflows. Representative obstructions are shown in Figures 1 - 9. Pertinent data on all obstructions to floodflows are contained in Table 9, page 41.

Figure 1 - Bridge over the Calaveras River at Ashley Lane.

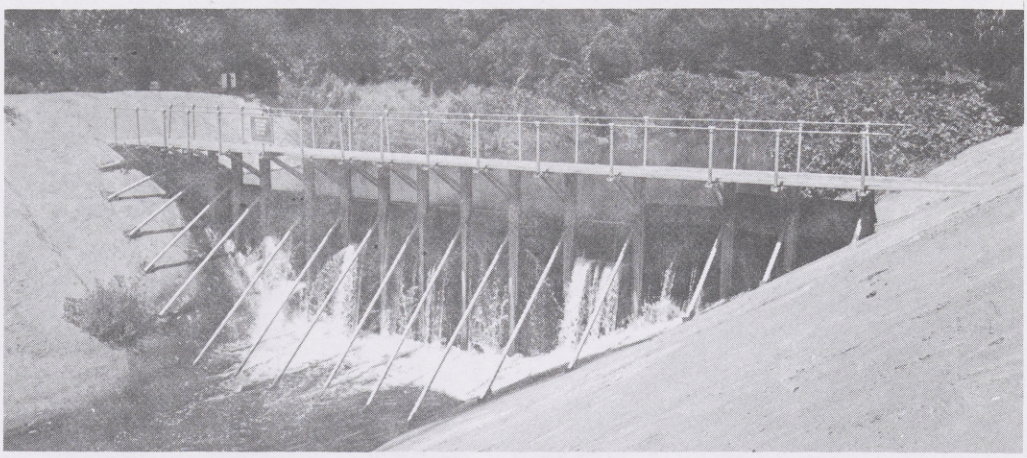

Figure 2 - Irrigation diversion structure on the Calaveras River upstream from Eight Mile Road.

Figure 3 - Privately owned farm access bridge over the Calaveras River. The bridge is on a road joining Comstock Road between Clements and Messick Roads.

Figure 4 - Low water crossing of Mormon Slough on a private road southeast of Linden and south of Flood Road.

Figure 5 - Railroad bridge at the Southern Pacific crossing of the Stockton Diverting Canal.

Figure 6 - Privately owned bridge over Bear Creek. The bridge is upstream from Highway 88.

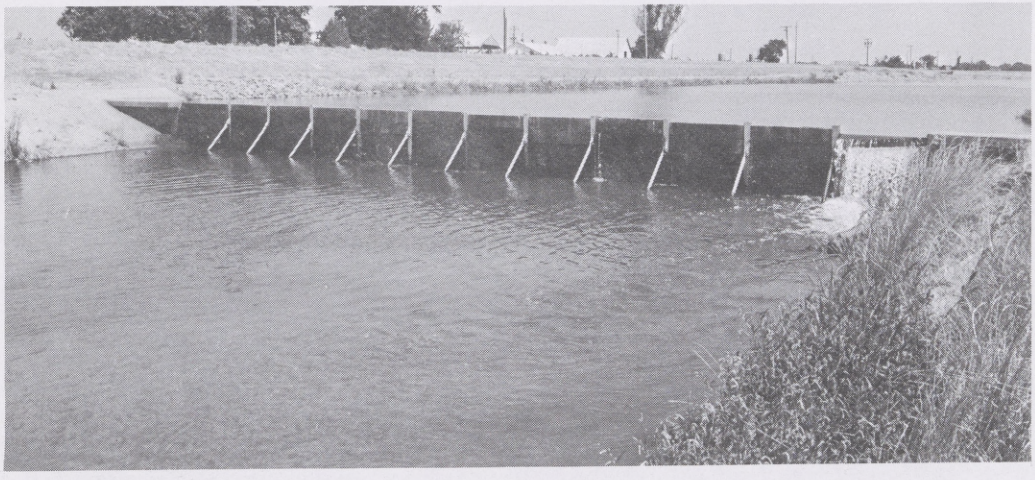

Figure 7 - Irrigation diversion structure on Bear Creek near Harney Lane.

Figure 8 - Pipeline crossing Mosher Creek between Highway 88 and Jack Tone Road.

Figure 9 - Bridge over Paddy Creek at Harney Lane.

Flood Damage Reduction Measures.

Four projects provide flood protection in the study area. Foremost of these is New Hogan Lake, a multiple purpose storage project built by the Corps of Engineers on the Calaveras River about 28 miles east of Stockton. This project comprised enlargement of an existing reservoir owned and operated by the city of Stockton. It consists of an earth

and rockfill dam 1,960 feet long and 200 feet high, a 325,000 acre-foot reservoir, auxiliary dikes at low spots in the reservoir periphery, a gated spillway, and outlet works for flood control and irrigation releases. Construction of the dam was started in 1960 and the project was placed in operational status in 1964. Since its completion, New Hogan Lake has prevented flood damage estimated at $1,200,000.

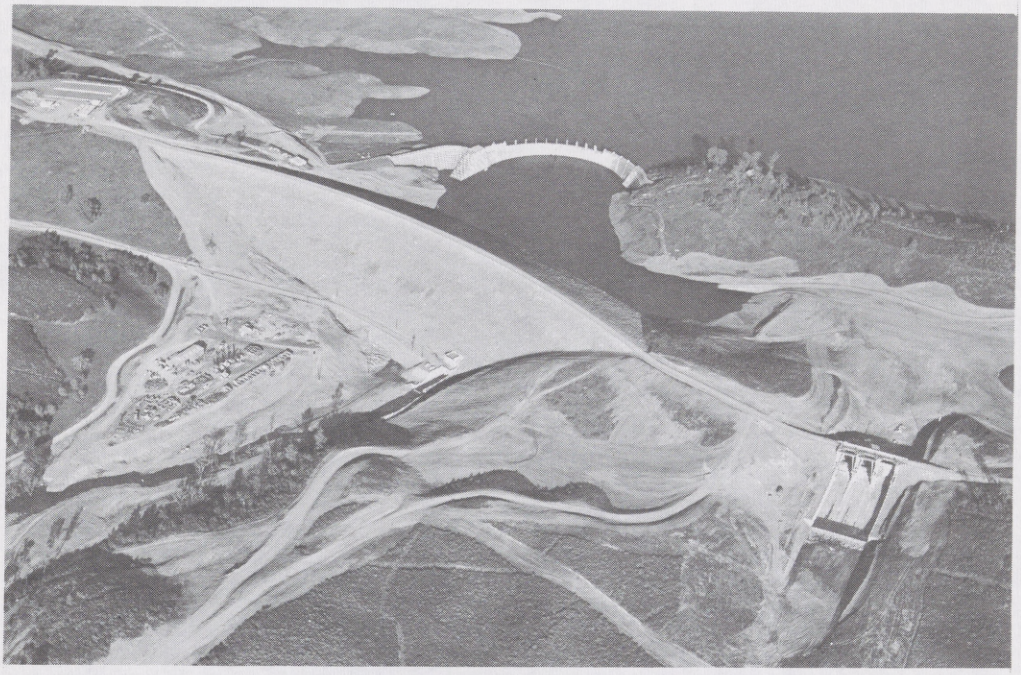

Figure 10 - New Hogan Dam shortly after completion. The original Hogan Dam, which was left in place, is completely submerged when New Hogan Lake is full.

In the early 1900's, a Corps of Engineers navigation project to divert Mormon Slough flows to the Lower Calaveras River just north of Stockton was built to prevent siltation of the deep water harbor in Stockton. The project consisted primarily of constructing a dam across Mormon Slough and excavating a diverting canal from the slough to the river. A levee was built along the south (Stockton) side of the canal. It provided incidental flood protection to a large part of Stockton and adjacent suburban areas. With completion of the New Hogan Project in 1964, increased capacity in the Calaveras River system downstream from

Bellota was required for flexibility in project operation, and for containment of operational releases and inflow downstream from the lake. The necessary increase was provided by a Corps of Engineers flood control project comprising major and minor channel enlargement along Mormon Slough and the Stockton Diverting Canal, bank protection work along the lower Calaveras River, a levee along the north side of the Diverting Canal, pumps for local storm drainage that would pond on the land side of the Diverting Canal north levee, and other miscellaneous improvements. Work on the project was completed in 1970. In addition to providing flood protection, the project also serves the older navigation project function of preventing siltation in the Stockton deep water harbor.

A flood control project for Bear Creek was completed by the Corps of Engineers in 1962. It consists of levees and improved channel along Bear Creek and the lower reaches of Paddy Creek and its tributaries.

Figure 11 - A segment of improved channel along Bear Creek.

The Soil Conservation Service completed a flood damage reduction project on Mosher Creek in 1971. Project works include watershed treatment to reduce runoff and sediment production, a leveed channel to

divert flows from upper Mosher Creek to Bear Creek, and improved channel to carry floodflows originating downstream from the diversion.

Figure 12 - The Mosher Creek Diversion.

Existing flood control works provide, as a minimum, protection against floods expected to occur about once in 50-60 years on the long-term average. A higher degree of protection is afforded some parts of the study area. The pumping plants along the Diverting Canal north levee have no significant effect in reducing flood areas.

San Joaquin County has not fully enacted flood plain zoning ordinances that would guide development of flood prone lands toward optimum uses commensurate with the flood hazard. At present, riparian areas are zoned for agricultural uses and structures are required to be set back from levees. The county is eligible for flood insurance under the emergency program of the Federal Insurance Administration, Department of Housing and Urban Development. To maintain eligibility, the program requires adoption and enforcement of land use and control measures that will guide future development of flood prone areas in such a way that flood damage is avoided or significantly reduced. Consideration of comprehensive land use planning, including flood plain regulation, is pending completion of this report.

Other Factors and Their Impacts.

Flood warning and forecasting. - The National Oceanic and Atmospheric Administration (NOAA), through its National Weather Service (NWS), maintains year-round surveillance of weather conditions. NOAA storm forecasts pertinent to the study area are furnished to the NWS office in Sacramento for distribution directly to agencies responsible for flood protection and, by way of the local news media, to the general public.

Personnel from the NWS office in Sacramento and the California Department of Water Resources are assigned to the Joint Federal-State River Forecast Center, which monitors weather conditions and river stages on a year-round basis. If floods on major streams become imminent, the Federal-State Flood Operations Center is activated. This Center operates on a 24-hour basis and, among other flood emergency activities, advises all interested parties of flood situations as they develop. The Center furnishes flood warnings and forecasts of river stages to the local news media, law enforcement agencies, and other responsible agencies for their use and for dissemination to the public.

Although specific flood forecasts are not prepared for streams in the study area except for the Calaveras River system, applicable daily weather forecasts are issued by the NWS office in Sacramento. When weather conditions warrant, storm and probable flood warnings are issued by that office. The Corps of Engineers issues flood forecasts for the Calaveras River. The local news media and law enforcement agencies disseminate these warnings to the public.

Flood fighting and emergency evacuation plans. - There are no specific formalized plans for flood fighting or emergency evacuation of people and personal property from Linden or other parts of the study area. However, San Joaquin County has a standing emergency plan that covers floods as one of several possible emergency situations. The plan establishes an emergency services council and directs a variety

of actions for pre-emergency, actual emergency, and post emergency situations. The California Department of Water Resources, through the Flood Operations Center, coordinates flood fighting activities throughout the State and is authorized to receive requests from local public agencies for assistance during floods. The Corps of Engineers responds to requests for flood fighting and rescue work from the California Office of Emergency Services (OES) when the emergency is beyond the capabilities of State and local governmental agencies.

Pursuant to the provisions of Section 8589.5, Government Code of California, emergency procedures must be established for the evacuation and control of areas of potential flooding in the event of sudden failure of dams. Portions of the Northeast Stream Group area would be subject to inundation if New Hogan Dam should suddenly fail. Therefore, under the law, the Corps of Engineers must prepare a map showing areas that would be inundated and submit it to the OES. On the basis of the map, the OES in cooperation with the California Department of Water Resources will designate evacuation areas. The local jurisdiction must then adopt emergency evacuation procedures that include, among other things, specific routes to be used for evacuation; traffic control measures; movement of people without their own transportation; shelter of evacuees; evacuation and care of people from institutions; and perimeter security, interior security, and reoccupation of evacuation areas. The inundation map is scheduled for completion in March 1974. It is expected that development of evacuation procedures will take about 1 year following OES approval of the inundation map.

Storage of floatable materials in flood plain areas. - Floatable materials resulting from agricultural, commercial, and industrial operations, or from other activities, may be picked up and carried away by floodwaters; thereby increasing flood losses and intensifying the flood hazard by collection on bridges or plugging culverts and obstructing the passage of floodflows.

In the study area, accumulation of significant quantities of floatable materials would not result from residential uses. Due to the intense agricultural development throughout the study area, accumulations of large quantities of crates and cartons preparatory to harvesting or product packing operations could be stored temporarily in flood plain areas. Prunings from orchards are usually left on the ground and are subject to being picked up and carried away by floodwaters. Consequently, the presence of floatable materials constitutes a minor added hazard and potentially greater monetary loss may result during floods.

PAST FLOODS

SUMMARY OF HISTORICAL FLOODS

From Indian legends and the journals of explorers and the earliest settlers, it is known that widespread flooding occurred in the Calaveras River and adjoining stream basins in 1776, 1805, 1826, 1828, and 1830. Flooding also occurred in this area in 1847, but it was not as severe as during the earlier floods. Available information indicates that floods of destructive magnitude occurred 14 times during the last half of the 19th Century. Nineteen flood events are documented for the 65-year period beginning in 1907. In general, floods that occurred in December 1955 and April 1958 were the largest and most damaging known in the study area. A flood that occurred in January 1911 was the greatest of record on the Calaveras River, but damage in the study area was much less than in 1955 and 1958 because the flood plains were devoted mostly to agriculture or were unused. Other major floods since the turn of the century occurred in 1907, 1909, 1921, and 1938. On Bear Creek, 1945 and 1964-65 also were major flood years. Comparative flows for observed floods since the turn of the century are shown in Table 6, page 24.

It should be noted that damage in the study area during most of the known past floods would have been significantly reduced if the floods had occurred with presently existing flood control facilities completed and in operation.

FLOOD RECORDS

Information on flooding in the study area prior to 1900 is practically non-existent. Streamflow records extend from 1907 to the present

TABLE 6

HISTORICAL FLOODFLOWS

Flood	Flow[a] c.f.s. Mormon Slough at Bellota	Calaveras River at Jenny Lind	Bear Creek at Lockeford
March 1907	*(b)*	34,600	*(b)*
January 1909	*(b)*	33,000	*(b)*
January-February 1911	*(b)*	50,000	[2,700]
January 1916	*(b)*	22,000	*(b)*
February 1917	*(b)*	31,300	*(b)*
March 1918	*(b)*	21,800	*(b)*
January 1921	*(b)*	37,900	*(b)*
February 1922	*(b)*	24,500	*(b)*
February 1925	*(b)*	27,500	*(b)*
February 1936	*(b)*	[26,000] 10,100	[1,700]
February 1938	*(b)*	[32,000] 10,600	*(b)*
February 1945	*(b)*	[22,000] 7,200	2,300
November-December 1950	[9,000]	[23,000] 7,600	800
December 1955	[16,000]	[33,000] 14,200	1,800
April 1958	15,400	[42,000] 12,100	3,000
February 1963	6,700	[25,000] 6,900	1,500
December 1964-January 1965	3,300	[20,600] 2,600	2,400*(c)*
December 1966-January 1967	*(d)*	*(d)*	1,500
January 1969	10,700	[20,000]*(e)*	800

(a) Flow values shown in [ ] are estimated. For the Jenny Lind station, estimated peaks do not reflect the effect of old Hogan Dam (1936-1963) or New Hogan Lake (1964 and later); recorded flows are also shown for comparison. All flow values are rounded.

(b) Station not in operation.

(c) January peak flow. A 2,300 cubic foot per second flow occurred in December.

(d) Runoff from the Calaveras River Basin not significant.

(e) Station discontinued.

for the Calaveras River, and from the 1930's to the present for Bear Creek. Descriptive data on flood events since the turn of the century may also be found in newspaper files; the authorization documents for the flood control projects on the Calaveras River and Bear Creek; certain of the design documents for these projects; publications of the U.S. Geological Survey and U.S. Weather Bureau (now National Weather Service); and, since 1950, in unpublished post-flood reports prepared by the Corps of Engineers.

FLOOD DESCRIPTIONS

With the exception of the knowledge that they occurred, nothing definitive is known about the early historical floods in the study area. Similarly, information on the 14 flood periods of the last half of the 19th Century is very limited. It is recorded, however, that valley floor areas of the Calaveras River and Bear Creek were entirely inundated during a number of these floods, roads were damaged and bridges swept away, and many farms were isolated. Floods that occurred in 1861-62 were the most severe known during that half century. Flood stages and estimated peak flows that have never been equalled or exceeded occurred during the 1861-62 flood season. Flooding on the valley floor was deep enough to permit riverboats to reach almost any locality in the inundated area. Floods that occurred in 1866-67 approached the magnitude of those in 1861-62.

The major floods that occurred during the earlier part of the 20th Century (March 1907, January 1909, January-February 1911, and January 1921) were all very similar in their impact on the study area. The 1911 flood had a materially larger peak flow, but little else distinguished it from the other large floods of the period. Contemporary descriptive material on these floods predominantly relates to the Calaveras River. Bear Creek is infrequently mentioned. However, very high flows are known to have occurred on Bear Creek, and its overflow to the south commingled with Calaveras River floodwater. In the

Calaveras River system, flooding was widespread, frequently extending entirely across the area between Mormon Slough and the Calaveras River in the vicinity of Linden, which was entirely flooded a number of times during the period. Subsequent to construction of the Diverting Canal (1910), floodwater ponded on its north side and extended far to the north and east. In 1911, floodwater extended in a solid sheet west from the Southern Pacific crossing of Mormon Slough to the Diverting Canal, a distance of about 7 miles. During that flood, the levee along the south side of the Diverting Canal was overtopped. During all of the floods of the first quarter of the present century, the study area was frequently described as an inland sea. These floods caused extensive damage and great hardship, and repair, restoration, and recovery created major financial burdens on the county government and on the individuals directly affected.

Subsequent to 1936, the original Hogan Dam and Reservoir had a tempering effect on flooding in the study area. A flood that would have reached major proportions was largely averted by that project in February 1938. Runoff was estimated to be the greatest since 1911, but detention of floodwater in the reservoir and opportune cold weather and snowfall in the mountains, which halted runoff, limited overflow in the study area to such an extent that only a few roads were closed at the Diverting Canal and flood damage was minimal. A potentially severe flood on the Calaveras River was also averted by Hogan Reservoir in February 1963. The 1938 flood on Bear Creek was severe, and a large area was inundated in the vicinity of the Highway 99 crossing. In February 1945, Bear Creek flow approached that estimated for 1911, and flooding occurred along both sides of the stream throughout the study area. Flood conditions continued for four days.

Flooding in the study area under conditions of economic development generally as they now exist is exemplified by the following descriptive material on the 1955, 1958, and 1964-65 floods. These floods occurred

prior to completion of now-existing flood control facilities, which would have made them essentially nondamaging in the study area. They are briefly described here because they were the most severe known in relatively recent years. It must be noted, however, that the largest past floods of record on the Calaveras River would not approach the Intermediate Regional Flood in severity and extent and depth of inundation, if existing flood control facilities had been completed and in operation when those floods occurred. In the Bear Creek sector of the study area, the areas inundated by a Standard Project Flood (with existing flood control facilities in operation) would closely approximate those inundated in April 1958, which was prior to construction of these facilities.

December 1955.

The most widespread and destructive flood of any in the recorded history of the Central Valley occurred in December 1955. Flood runoff

Figure 13 - Floodwater at the Diverting Canal and south of Highway 26, December 1955. View is easterly from the highway bridge. (Stockton Record photograph.)

Figure 14 - Calaveras River floodwater northerly of the Highway 99 crossing of the Diverting Canal, December 1955.

from the Calaveras River at that time was the largest known for many years. Peak flow on Bear Creek as measured at the Lockeford gage was less than the then record peak flow of February 3, 1945. Floodwater broke out of the Calaveras River to inundate farmlands in the vicinity of Linden. Mormon Slough breached its levees and flooded along both sides from Bellota to the Diverting Canal. An extensive area north and east of the canal was inundated. In total, about 10,000 acres were flooded in the study area (5,400 acres in the Calaveras River portion and 4,500 acres in the Bear Creek portion), and flood damages totalled about $700,000. Flood losses consisted mostly of damage to farm equipment, fences, irrigation facilities, and other farm and ranch improvements; cost of cleanup; and cost of releveling croplands. Damage to

public facilities (roads, bridges, levees, etc.) and the publicly borne costs of floodfighting were also extensive. Residential losses consisting of damage to rural dwellings and their contents totalled about $50,000. In the Bear Creek sector, the flooded areas were almost entirely agricultural in nature and losses consisted of damage to permanent pasture for dairy cattle, increased cost of livestock maintenance, some destruction of livestock, and damage to cropland used for alfalfa, sugar beets, and barley. Floodwater reached a maximum depth of 4 feet on the Calaveras River flood plain and remained on the land for as long as a week. On the Bear Creek flood plain, floodwater reached a maximum depth of 3 feet and took 2 weeks to completely recede.

April 1958.

During the 1958 floods, runoff on the Calaveras River was the greatest experienced since 1911, and the largest flow ever recorded occurred on Bear Creek. Hogan Reservoir filled and spilled for the first time since its completion. In total, about 22,000 acres in the study area were flooded. Most of the area inundated was farm, crop, and orchard land except for some developing rural residential and commercial areas along Highway 99 and north of the Diverting Canal. About 3,000 acres of farmland in the vicinity of Linden were flooded by the Calaveras River where two levee breaks occurred. Linden was threatened but not damaged. Levees along Mormon Slough were breached in a number of locations and about 7,000 acres of land flooded in a strip extending from Bellota to the Diverting Canal. A major levee break occurred near the head of the Diverting Canal. Flooding also occurred on 1,500 acres along the north side of the Diverting Canal. About 11,000 acres were flooded by Bear Creek; the area inundated extending across the entire study area and ranging from about 3 miles wide in the upper portion to about 5 miles wide at Highway 99. Floodwaters averaged about 2 feet deep and remained on the land for 2-10 days in the Calaveras River portion of the study area. They reached a maximum depth of 3 feet and remained on the land for as long as 3 weeks in the Bear Creek portion.

Figure 15 - Floodwater at the Duncan Road crossing of Mormon Slough, April 1958. (Stockton Record photograph.)

Figure 16 - Overflow from Bear Creek between Shippee Road and Hildreth Lane near Highway 99, April 1958. (Stockton Record photograph.)

The areas flooded were used principally for orchards, pasture, and crop production. However, developing rural residential areas and some commercial establishments were inundated in the areas north of the Diverting Canal and along Highway 99. Flood losses totalled about $1,400,000 and consisted of damage to fruit and nut orchards; damage to growing truck crops, alfalfa, and barley; reduced dairy and poultry production; loss of stored feed and supplies; damage to cropland by erosion and deposition of flood borne debris and sediment; the costs of cleanup, restoration and repair of farm and ranch improvements; and the costs of repairing railroad and public utility systems. Publicly borne flood losses included the costs of repair and restoration of roads, bridges, and levees, and the cost of extensive floodfighting, which prevented damage that otherwise would have been catastrophic.

December 1964-January 1965.

Widespread flooding occurred in northern and central California and western Nevada in December 1964 and January 1965. Severe storms occurred over the watershed tributary to the study area and the second highest peak flow of record occurred on Bear Creek. However, flooding and flood damage was minimal because the levee and channel improvement project was nearly finished at the time and functioned effectively to prevent an estimated $500,000 damage to agricultural and suburban residential developments. Flood losses in the Bear Creek study area during the flood period consisted of minor damage to electrical utility facilities and costs of levee repair. New Hogan Lake, which became operational just prior to the flood season, stored runoff from a moderately large flood and controlled flows downstream to non-damaging amounts.

FUTURE FLOODS

Although flood producing storms of the same magnitudes as those that have occurred in the past could recur in the future, discussion of future floods in this report is limited to those that have been designated as the Intermediate Regional and Standard Project Floods. The Standard Project Flood would be larger and would occur less frequently than the Intermediate Regional Flood. A Standard Project Flood would be a rare event, but could reasonably be expected to occur. Selection of these floods was based on hydrologic computations, which include analysis of available records of past floods, and consideration of pertinent meteorologic and physiographic conditions. As previously indicated, general rainfloods or cloudbursts would create the more severe flood conditions in the study area.

During floods, debris collecting against obstructions causes greater water depths (backwater effect) upstream. Since the occurrence and amount of debris are indeterminate factors, only the physical characteristics of obstructions were considered in preparing the maps and other illustrations showing the Intermediate Regional and Standard Project Floods. These maps and illustrations reflect consideration of vegetation normally existing in floodways, and show the backwater effect of obstructions, but do not reflect increased water surface elevations that could be caused by debris collecting against obstructions, or by future deposition of silt in stream channels or under bridges.

INTERMEDIATE REGIONAL FLOOD

The Intermediate Regional Flood is one that could occur about once in 100 years on the average, although it may occur in any given year. Peak flows for the Intermediate Regional Flood on streams in the study area were derived from statistical analyses of available streamflow and

precipitation records, or, where such records were not available, were synthesized from rainfall and streamflow data from nearby stream basins having hydrological, meteorological, and physiographic characteristics similar to those in the study area. Peak flows thus developed, taking into account basin runoff characteristics, flood control operation of New Hogan Lake, ground saturation conditions, and losses from surface pondage and other factors, are shown in Table 7. Synthesized stage hydrographs of the Intermediate Regional Flood at various locations in the study area are shown on Plates 2-5.

STANDARD PROJECT FLOOD

The Standard Project Flood is that which may be expected from the most severe combination of meteorological conditions, either general rain or cloudburst, reasonably characteristic of the geographical region. Peak flows for the Standard Project Flood, which were developed in the same manner as described for the Intermediate Regional Flood, are also shown in Table 7.

FREQUENCY

Frequency analyses for the Calaveras River and Bear Creek were based on records of rainflood flows, available precipitation records, and computed peak flows of floods up to the magnitude of the Standard Project Flood. The analyses, which reflect the judgment of hydrologists familiar with the region, show that the 1950, 1955, 1958, 1964-65, and 1969 floods had frequencies of occurrence as summarized in Table 8, page 36. The floods included in the table are those considered to be representative of recent flood events. Frequency analyses for past floods on Mosher, Paddy, Middle Paddy, and South Paddy Creeks were not made because precipitation and flow data for these streams are not available.

As previously indicated, an Intermediate Regional Flood has a frequency of occurrence of about once in 100 years on the average, and a Standard Project Flood would occur less frequently than an Intermediate Regional Flood. Although the Standard Project Flood would be a rare event, it can

reasonably be expected to occur in the future. Floods larger than the Standard Project Flood are possible, but their occurrence would be extremely rare.

TABLE 7

PEAK FLOWS FOR INTERMEDIATE REGIONAL AND STANDARD PROJECT FLOODS

Location	Intermediate Regional Flood c.f.s.	Standard Project Flood c.f.s.
CALAVERAS RIVER		
Escalon-Bellota Road	0[(a)]	500
Jack Tone Road	800	1,700
Highway 99	800	1,200
MORMON SLOUGH		
Escalon-Bellota Road	12,700	22,700
Copperopolis Road	12,800	17,100
STOCKTON DIVERTING CANAL		
Highway 99	13,600	14,700
BEAR CREEK		
Jack Tone Road	4,300	7,200
Highway 88	6,500	8,000
Highway 99	6,500	7,300
MOSHER CREEK		
Jack Tone Road	500	700
LOWER MOSHER CREEK		
Highway 99	400	1,000
PADDY CREEK		
Jack Tone Road	1,300	1,900
At mouth of South Paddy Creek	2,600	3,700
MIDDLE PADDY CREEK		
Jack Tone Road	800	1,200
SOUTH PADDY CREEK		
Jack Tone Road	500	700

(a) Division of flow structure prevents flow to Calaveras River during an Intermediate Regional Flood.

TABLE 8

FREQUENCY DATA

Flood	Flow c.f.s.	Frequency[a] years: At time of flood	Frequency[a] years: Under existing conditions of control
CALAVERAS RIVER AT JENNY LIND			
November-December 1950	7,600	30	40
December 1955	14,200	70	130
April 1958	12,100	70	100
February 1963	6,900	20	35
December 1964-January 1965	2,600	5	10
December 1966-January 1967	*(b)*	*(b)*	*(b)*
January 1969	*(c)*	*(d)*	*(d)*
MORMON SLOUGH AT BELLOTA			
November-December 1950	9,000*(e)*	30	50
December 1955	16,000*(e)*	70	190
April 1958	15,400	70	170
February 1963	6,700	20	30
December 1964-January 1965	3,300	5	10
December 1966-January 1967	*(b)*	*(b)*	*(b)*
January 1969	10,700	30	90
BEAR CREEK AT LOCKEFORD			
November-December 1950	*(f)*	*(f)*	*(g)*
December 1955	1,800	5	*(g)*
April 1958	3,000	40	*(g)*
February 1963	1,500	3	*(g)*
December 1964-January 1965	2,400	20	*(g)*
December 1966-January 1967	1,500	3	*(g)*
January 1969	*(f)*	*(f)*	*(g)*

(a) Approximate values are shown due to lack of data for more precise evaluation.

(b) Runoff from the Calaveras River Basin not significant.

(c) Station discontinued.

(d) Frequency estimated to be in the same order as shown for Mormon Slough at Bellota.

(e) Estimated.

(f) Flood very minor in Bear Creek Basin.

(g) There would be no change in frequency because existing projects do not affect flow at the Lockeford gage.

HAZARDS OF LARGE FLOODS

The amount and extent of damage, and the attendant flood hazard, from any flood depends upon the depth and duration of flooding, velocity of flow, rate of rise, and the developments in the flood plain. An occurrence of an Intermediate Regional or Standard Project Flood on streams in the study area, with existing flood control facilities and under present conditions of development, would result in extensive inundation of suburban residential areas; commercial and light industrial areas; and agricultural lands devoted to orchards, row and field crops, and grazing. The entire community of Linden would be subject to flooding. Many miles of major surface arteries, county roads, and railroad track would be overtopped and rendered impassable for varying periods; and roadway, bridges, and railroad embankment would be damaged. Existing private and publicly owned levees and improved channel sections would be damaged by erosion and deposition of debris.

Floodwater flowing at high velocity and carrying floating debris would create conditions hazardous to persons attempting to cross flooded areas on foot or in vehicles. In general, floodwater 3 or more feet deep and flowing at a velocity of 3 or more feet per second could easily sweep a person off his feet, thus creating definite danger of injury or drowning. Rapidly rising and swiftly flowing floodwater may trap persons in homes that are ultimately isolated or in vehicles that could be stranded. Sewage, garbage, and other organic materials carried or deposited by floodwater could create health hazards, and isolation of areas by floodwater could create short-term medical, fire, or law enforcement emergencies.

Water lines can be ruptured by deposits of debris or the force of floodwater, thus creating the possibility of contaminated domestic water supply. Storage facilities for toxic liquids and gasses can be damaged or destroyed by floodwaters and create hazards such as the

possible poisoning of water supply, destruction of livestock, destruction of fish and wildlife, and varied ecological damage.

FLOODED AREAS AND FLOOD DAMAGES

The approximate limits of inundation that would result from Intermediate Regional and Standard Project Floods are shown on Plate 6, which is also an index to more detailed maps showing the areas that would be inundated by these floods (Plates 7-14). As may be seen from the plates referred to, the Intermediate Regional and Standard Project Floods would inundate extensive areas and there could be some intermingling of floodwaters from various sources.[(a)] Flooding would extend entirely across the western portion of the study area except for small "island" areas between Mosher and Bear Creeks, and a large "island" between the Calaveras River and Mosher Creek. In general, floodwaters would pond against Highway 99 and the Diverting Canal and extend easterly therefrom across the entire study area in narrowing bands. The entire area between Mormon Slough and the Calaveras River, including the community of Linden, would be flooded except for one large and several small "islands." Isolated areas would be flooded in the central-northeast sector of the study area where exchange of floodwaters between the Calaveras River and Bear Creek would occur. "Island" areas that cannot be identified using available topographic data would occur in various sectors of the flood areas. As indicated on the maps, most flooding would be sheet flow in nature. The area that would be inundated by an Intermediate Regional Flood totals about 5,650 acres, of which 3,030 acres are open or agricultural lands, 1,680 acres are urban, and 940 acres are streamway. The area inundated by an Intermediate Regional

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(a) *It should be noted that all of the flooded areas shown on Plates 7-14 would not be inundated at the same point in time because flood producing storms over the various drainage basins would not necessarily occur concurrently.*

Flood would be smaller than that inundated during some historical floods due to existing flood control facilities.

Flood damage would be mostly agricultural in nature except in the community of Linden and developing rural residential and commercial areas along Highway 99, and near the confluence of the Diverting Canal and Calaveras River. Agricultural losses would include erosion of and deposition of debris and silt on crop and pasture lands; damage to orchards due to flooding of trees; damage to farm improvements such as irrigation systems, diversion facilities, and fences; possible loss of growing crops, livestock, and poultry; and increased cost of livestock maintenance. Other flood losses would include damage to roadbeds and bridges; damage to railroad track, embankment, and stream crossings; erosion of streamways and damage to communications and utility distribution systems. Residential losses would include damage to foundations, floors, furnishings, and lawns and gardens. Commercial and light industrial losses would primarily comprise damage to structures and equipment, loss of business and inventories, and costs of cleanup and repair.

Due to the wider flood plain, greater depth of flooding, and higher velocity of flow during a Standard Project Flood, damage would be more extensive than during an Intermediate Regional Flood. Plates 15-32 show water surface profiles of the Intermediate Regional and Standard Project Floods. Depth of flow in channels can be estimated from these illustrations. Typical cross sections of flood plains at selected locations in the study area, together with the water surface elevation and lateral extent of the Intermediate Regional and Standard Project Floods are shown on Plates 33-37. Data for approximately 1,000 cross sections were developed and used in the preparation of this report.

The impact of flooding is not limited to areas actually flooded. For example, floodwaters may interrupt or contaminate domestic and industrial water supply being conveyed by the Mokelumne Aqueduct or break

sewer mains that an entire subdivision depends upon, thus creating inconvenience and potential hazards to health. Interruption of surface transportation or public utility services by floods may affect areas considerably removed from those actually flooded and result in personal discomfort and inconvenience, cessation of industrial and commercial activities and attendant loss of business and worker income. Emergency situations could be very difficult to deal with due to lack of communication or transportation. Meeting the costs of emergency flood relief, flood fighting, other flood emergency activities, cleanup, and the repair and restoration of public facilities damaged or destroyed by floods has an impact that far transcends the flooded areas because city, county, state, and Federal tax revenues must be used, thus reducing revenues available for other services, especially on the local level. Other results of flooding that impact outside the flooded areas may also include closed schools and inconvenience to the traveling public. Farm center communities such as Linden could suffer from loss of business activity when agricultural areas upon which the community depends are flooded and crops are lost or significantly reduced below normal levels.

OBSTRUCTIONS

As previously noted, there are many obstructions to floodflow in the study area. Pertinent data on obstructions are contained in Table 9. As may be seen from Plates 15-32, the effect of obstructions is to raise the water surface elevations upstream. Obstructive bridges are especially susceptible to structural damage from the forces of floodwater and floating debris.

TABLE 9

OBSTRUCTIVE BRIDGES, DIVERSION STRUCTURES, AND LOW WATER CROSSINGS

Identification	Location (b)	Elevation(a) Stream-bed	Top of under-clearance (c)	Roadway (c)	Intermediate Regional Flood	Standard Project Flood
		CALAVERAS RIVER				
Private Road	5.96	15	26	27	27	30
Diversion Structure	6.48	17	(d)	22(e)	27	30
Highway 99 (Northbound Lane)	7.32	22	33	38	31	33
Solari Ranch Road	9.31	32	43	44	40	42
Diversion Structure	9.32	32	(d)	41(e)	40	42
Ashley Lane(f)	9.78	34	44	46	43	45
Alpine Road	10.87	39	54	56	49	51
Pezzi Road	11.69	44	57	60	53	56
Private Road-Diversion(g)	12.00	45	58	59	56	58
Private Road-Diversion(g)	12.50	48	62	63	58	61
Highway 88	12.88	50	68	74	59	62
Diversion Structure(h)	14.82	58	(d)	69(e)	67	71
Private Road	16.72	68	82	83	78	81
Diversion Structure	17.77	75	(d)	86(e)	85	88
Private Road	18.53	79	91	92	88	90
Private Road	19.05	81	93	94	90	93
Private Road	19.59	84	96	98	93	95
Private Road(i)	20.52	89	104	106	98	99
Clements Road-Diversion(g)	21.27	97	103	109	103	103
Private Road	21.97	99	109	110	110	110
Private Road	22.62	100	113	115	113	114
Private Road	23.40	102	117	119	115	118
		MORMON SLOUGH				
Panella Road	6.89	28	53	54	53	54
Diversion Structure	7.60	32	(d)	44(e)	56	58
Jack Tone Road	7.96	37	63	65	60	60
Copperopolis Road	10.05	48	73	77	72	75
Southern Pacific Railroad	11.01	53	81	87	78	81

(a) All elevations are rounded to nearest foot, mean sea level datum.

(b) Stream mile upstream from: The San Joaquin River on the Calaveras River; the Calaveras River on the Diverting Canal and Mormon Slough; Disappointment Slough on Bear Creek; Bear Creek on Lower Mosher, Mosher, and Paddy Creeks; and Paddy Creek on Middle Paddy Creek.

(c) Average elevation.

(d) Not Applicable.

(e) Top of flashboard frame.

(f) Refer to Figure 1, page 13.

(g) Combination bridge and diversion structure.

(h) Refer to Figure 2, page 14.

(i) Refer to Figure 3, page 14.

TABLE 9 (Continued)

Identification	Location	Elevation				
		Stream-bed	Top of under-clearance	Roadway	Intermediate Regional Flood	Standard Project Flood
		MORMON SLOUGH (Continued)				
Duncan Road	11.28	57	83	85	80	82
Milton Road	11.83	63	87	89	84	85
Diversion Structure	12.42	66	*(d)*	74*(e)*	88	89
Low Water Crossing*(j)*	13.63	77	*(d)*	80	97	99
Diversion Structure	13.75	77	*(d)*	85*(e)*	97	100
Flood Road	14.18	78	104	106	100	102
Diversion Structure	14.50	80	*(d)*	89*(e)*	102	105
Fine Road	15.43	89	109	114	108	112
Escalon-Bellota Road	17.97	102	129	131	123	129
		STOCKTON DIVERTING CANAL				
Sanguinetti Lane	0.30	9	32	34	28	30
North Wilson Way	0.77	10	32	35	29	30
Central California Traction Railroad	0.98	17	30	34	30	31
Cherokee Road	1.33	15	31	34	32	33
Waterloo Road (Highway 88)	1.72	18	36	38	33	34
Highway 99 (Southbound Lane)	1.86	18	34	38	34	34
Highway 99 (Northbound Lane)	1.88	18	34	38	34	35
Stockton Terminal and Eastern Railroad	2.23	18	35	39	35	36
Linden Road (Highway 26)	3.03	18	39	41	38	39
Southern Pacific Railroad*(k)*	3.58	22	41	44	40	41
Copperopolis Road	4.69	24	46	47	43	44
		BEAR CREEK				
Highway 99 (Southbound Lane)	7.44	27	41	45	41	41
Highway 99 (Northbound Lane)	7.46	27	41	45	41	42
Frontage Road	7.48	27	42	46	41	42
Central California Traction Railroad	8.54	34	45	49	46	47
Private Road	8.71	35	48	49	48	49
Private Road	9.37	39	53	54	51	52
Diversion Structure	9.65	41	*(d)*	47*(e)*	53	54
Alpine Road	10.34	44	58	59	57	58
Live Oak Road	11.13	49	62	64	62	63
Private Road	12.00	53	66	67	66	67
Diversion Structure	12.30	55	*(d)*	60*(e)*	68	69

(j) Refer to Figure 4, page 14.

(k) Refer to Figure 5, page 15.

TABLE 9 (Continued)

Identification	Location	Elevation				
		Stream-bed	Top of under-clearance	Roadway	Intermediate Regional Flood	Standard Project Flood
		BEAR CREEK (Continued)				
Highway 88	12.58	56	70	72	69	70
Private Road(*l*)	12.78	56	70	71	70	72
Harney Lane	13.47	58	72	73	71	73
Diversion Structure(*m*)	13.55	59	(*d*)	63(*e*)	71	73
Private Road	14.20	61	74	75	74	76
Kettleman Road	14.55	61	76	77	75	77
Private Road	15.60	68	82	83	81	82
Jack Tone Road	16.83	76	92	94	88	91
		MOSHER CREEK				
Diversion Structure	2.65	62	(*d*)	65(*e*)	68	69
Pipe Crossing(*n*)	2.90	63	70	71(*o*)	71	72
Jack Tone Road	3.40	67	76	77	74	74
		LOWER MOSHER CREEK				
Highway 99 (Southbound Lane)	8.40	27	36	42	33	35
Highway 99 (Northbound Lane)	8.42	28	36	42	33	35
Frontage Road	8.44	27	37	43	33	35
Diversion Structure	8.95	30	(*d*)	35(*e*)	34	36
Diversion Structure	9.99	38	(*d*)	42(*e*)	42	44
Low Water Crossing	10.23	39	(*d*)	44	45	47
Pipe Crossing	10.24	39	46	47(*o*)	45	47
Hildreth Lane	10.54	40	47	49	46	48
Eight Mile Road	11.17	42	51	52	47	50
Alpine Road	11.53	44	53	55	49	51
Private Road	12.42	49	55	56	55	57
Diversion Structure	12.50	49	(*d*)	53(*e*)	55	57
		PADDY CREEK				
Diversion Structure	0.90	63	(*d*)	67(*e*)	72	73
Harney Lane(*p*)	0.92	63	74	75	72	74
Private Road	2.44	74	83	84	82	82
Jack Tone Road	2.64	75	85	87	83	84
		MIDDLE PADDY CREEK				
Jack Tone Road	0.62	74	82	83	81	82

(l) Refer to Figure 6, page 15.
(m) Refer to Figure 7, page 15.
(n) Refer to Figure 8, page 16.
(o) Top of pipe.
(p) Refer to Figure 9, page 16.

VELOCITIES OF FLOW

During an Intermediate Regional Flood, average velocity of flow in the main channels of the streams under study would be as shown in Table 10, page 44.

TABLE 10

AVERAGE VELOCITIES OF FLOW,
INTERMEDIATE REGIONAL FLOOD

Stream	Velocity feet per second
Calaveras River	1-4
Mormon Slough	4-9
Stockton Diverting Canal	3-7
Bear Creek	4-6
Mosher Creek and Mosher Creek Diversion	2-4
Lower Mosher Creek	1-4
Paddy Creek	2-5
Middle Paddy Creek	3-5
South Paddy Creek	2-4

In the range of values shown, the lower value is the average velocity in the lower reach of the particular stream or streamway, and the higher value is the average velocity in the upper portion of the reach under study. Overland flow consists of sheet flow and ponding areas where velocity of flow ranges from 1-3 feet per second.

Water flowing at a rate of 8 feet per second or greater will cause severe channel erosion and is capable of transporting large rocks. Velocities in the range of 6 to 8 feet per second could erode fill around bridge abutments. Water flowing at about 2 feet per second or less will deposit debris and silt. It is expected that velocity of flow during a Standard Project Flood would be slightly higher than during an Intermediate Regional Flood.

RATES OF RISE AND DURATION OF FLOODING

Intense rainfall from general storms centered over the upper tributary area of the Calaveras River collects rapidly as runoff that reaches New Hogan Lake soon after the beginning of storms. Runoff from above the lake would

be collected and released according to standards of operation developed for the project. Intense rainfall from general storms over other tributary drainage areas, or rainfall from cloudburst storms centered over isolated areas, also collects rapidly as runoff that reaches the study area soon after the beginning of storms. Stream channels in the study area are well defined, but have limited capacities.[(a)] Flows from flood producing storms rapidly rise to greater than channel capacities and spread overland. The volume of runoff from general flood producing rainstorms is large because the storms may continue for several days, and overbank flow can continue for a similar period. The largest flood-producing cloudburst storms last for only a few hours, but the high intensity rainfall causes streams to rise rapidly to overbank flow conditions. Consequently, the volume of runoff is relatively small and overbank flow is of short duration.

The maximum rate of rise, height and time of rise, and duration above flood stage for the Intermediate Regional and Standard Project Floods on the Calaveras River, Mormon Slough, and Bear and Mosher Creeks are shown in Table 11, page 46. Synthesized stage hydrographs shown on Plates 2-5 were used in developing the table.

Since the majority of flooding in the study area is sheet flow that cannot be combined into a uniform water surface, and realistic hydrographs cannot be constructed, especially for the lower reaches of the study area, Table 11 has been limited to those streams and locations where the rate, height, and time of rise, and duration of flooding data can be determined with reasonable accuracy.

(a) Channel improvement projects along the streams were designed to carry floods expected to occur about once in 50-60 years on the long-term average. For purposes of this report, however, encroachment on freeboard area was assumed in passing floodflows.

TABLE 11

RATES OF RISE AND DURATION OF FLOODING

Flood	Maximum Rate of Rise ft./hr.	Height of Rise[a] ft.	Time of Rise[b] hrs.	Duration Above Flood Stage hrs.
	CALAVERAS RIVER (At Mile 12.40)			
Intermediate Regional	(c)	(c)	(c)	(c)
Standard Project	0.4	0.5	6	12
	(At Mile 23.00)			
Intermediate Regional	(c)	(c)	(c)	(c)
Standard Project	0.53	1.0	3	9
	MORMON SLOUGH (At Mile 12.10)			
Intermediate Regional	(c)	(c)	(c)	(c)
Standard Project	0.67	0.3	5	12
	BEAR CREEK (At Mile 16.40)			
Intermediate Regional	0.3	2.4	7	18
Standard Project	0.3	5.25	15	33
	MOSHER CREEK (At Mile 2.80)			
Intermediate Regional	0.2	1.5	10	26
Standard Project	0.14	2.0	20	46

(a) Flood stage to maximum flood level.
(b) Time period corresponding to height of rise, rounded to nearest hour.
(c) Intermediate Regional Flood not out of banks.

PHOTOGRAPHS, FUTURE FLOOD HEIGHTS

The levels that the Intermediate Regional and Standard Project Floods are expected to reach at various locations in the study area are indicated in the following photographs.

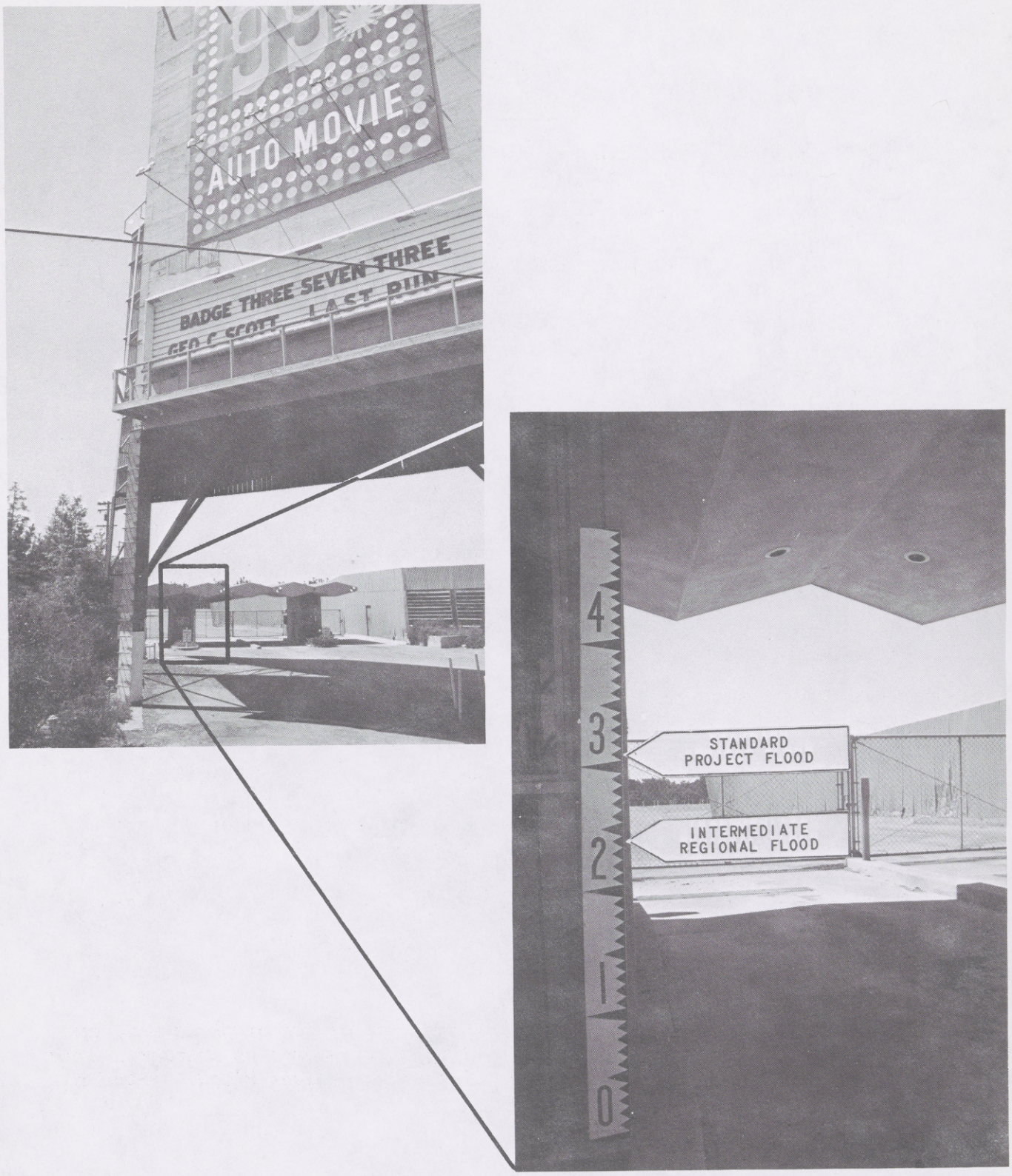


Figure 17 - Future flood heights in an overflow area near the junction of the Calaveras River and the Stockton Diverting Canal. The area under flood conditions is shown in the photograph on the following page.

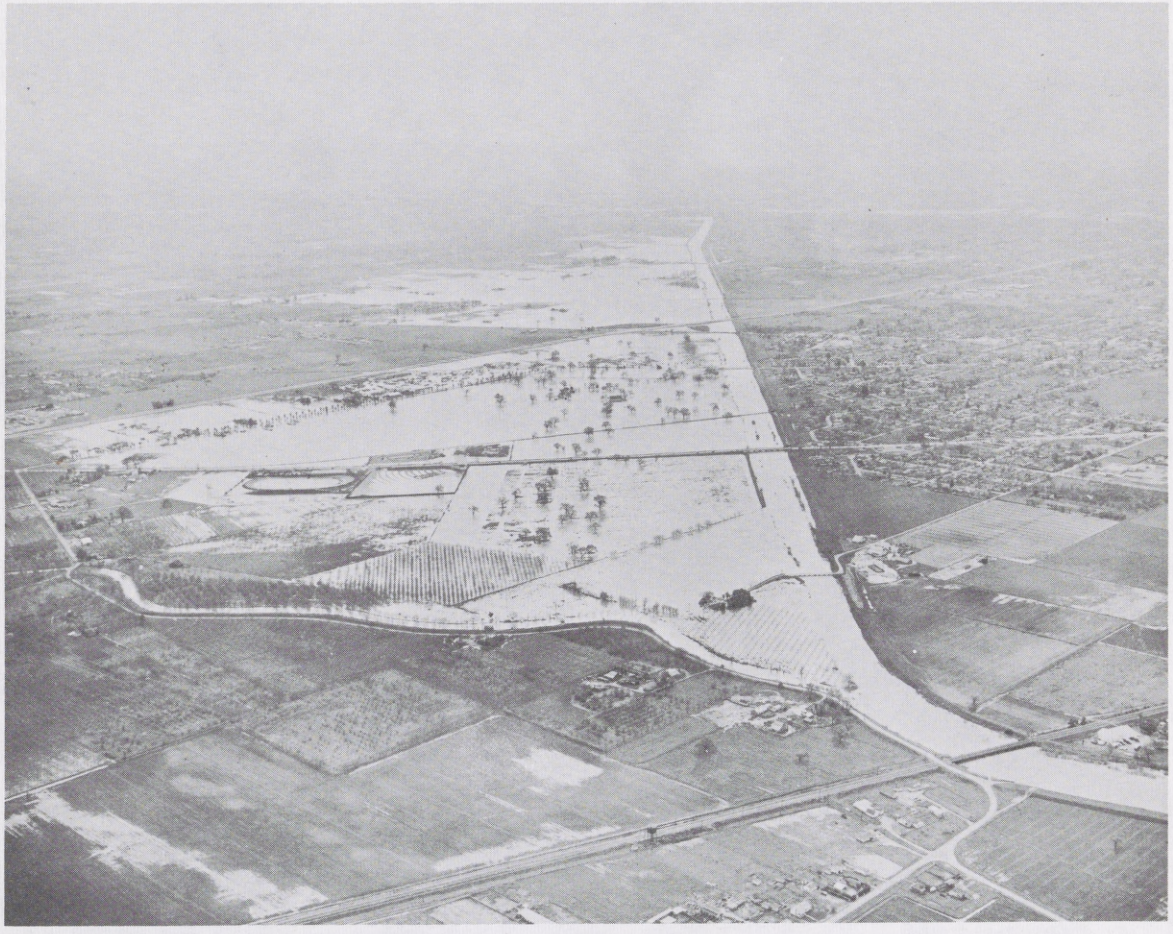


Figure 18 - Floodwater in the overflow area east of the Stockton Diverting Canal, April 1958. A much larger area would be inundated during an Intermediate Regional or Standard Project Flood. (Stockton Record Photograph.)

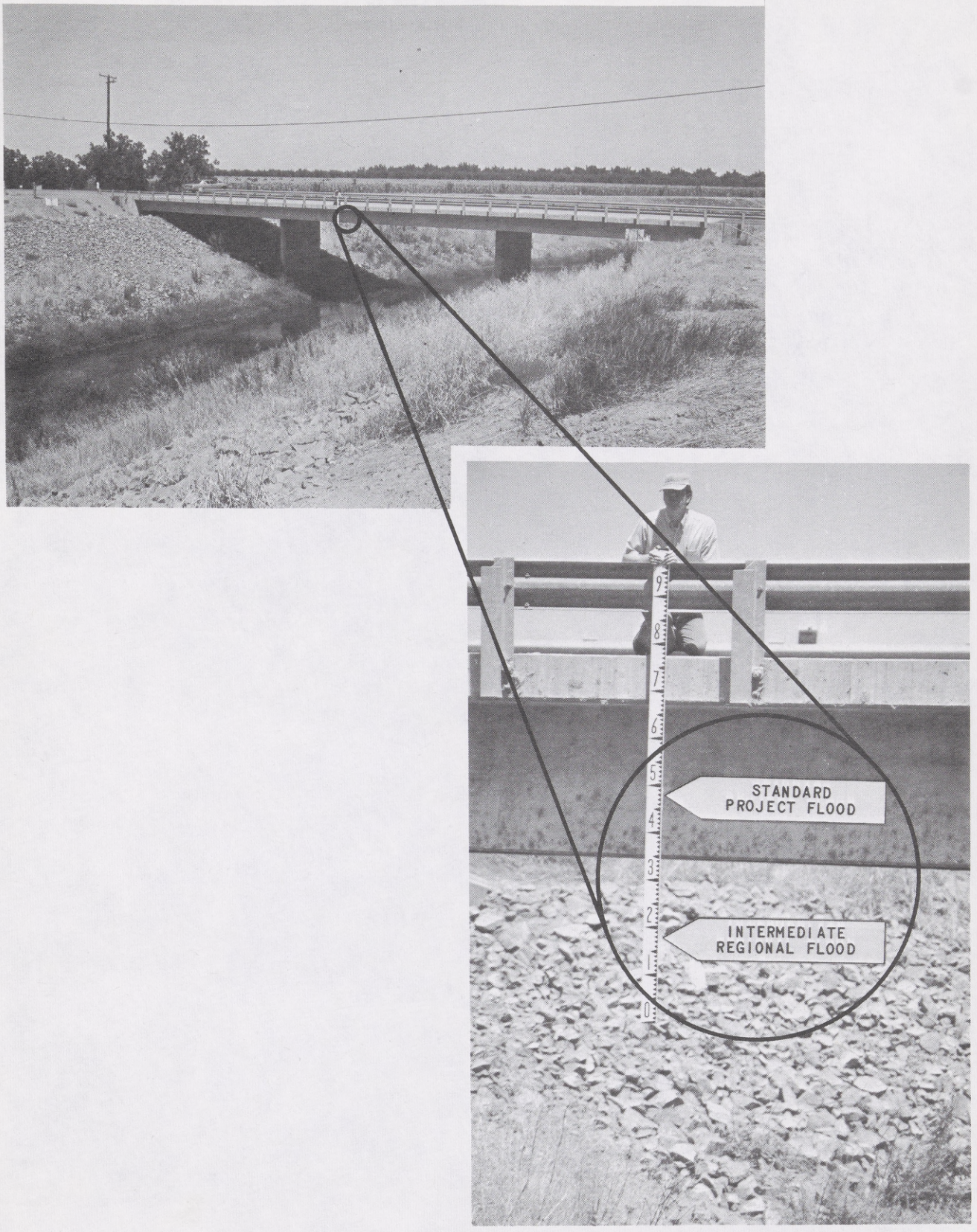


Figure 19 - Future flood heights at the Copperopolis Road crossing of Mormon Slough.

Figure 20 - Future flood heights in an overflow area adjacent to the Stockton Diverting Canal and near the junction of Highways 88 and 99.

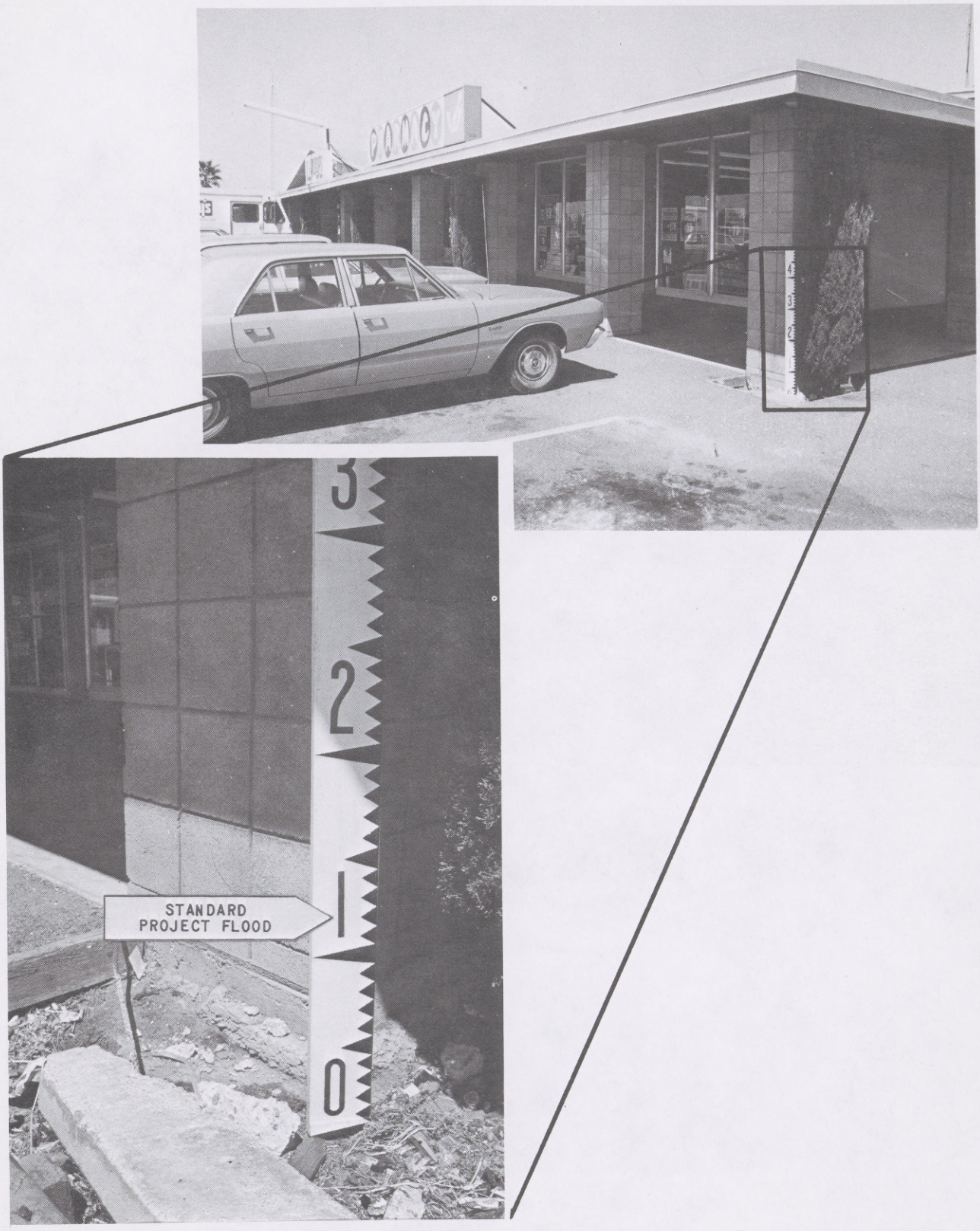


Figure 21 - Future flood heights in a Bear and Mosher Creeks overflow area in the Morada section.

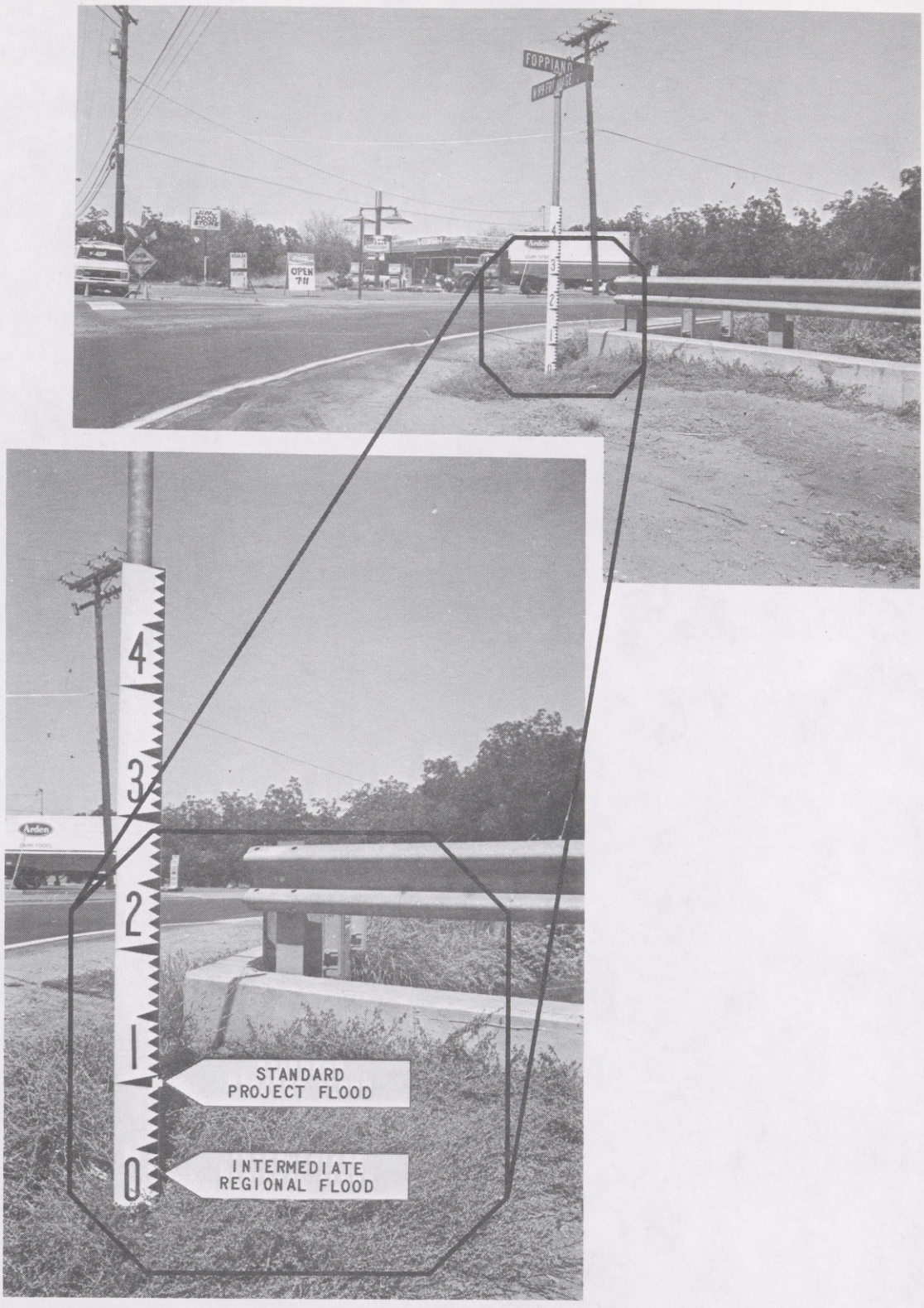


Figure 22 - Future flood heights in an overflow area of Lower Mosher Creek at Foppiano Road and the east Highway 99 frontage road.

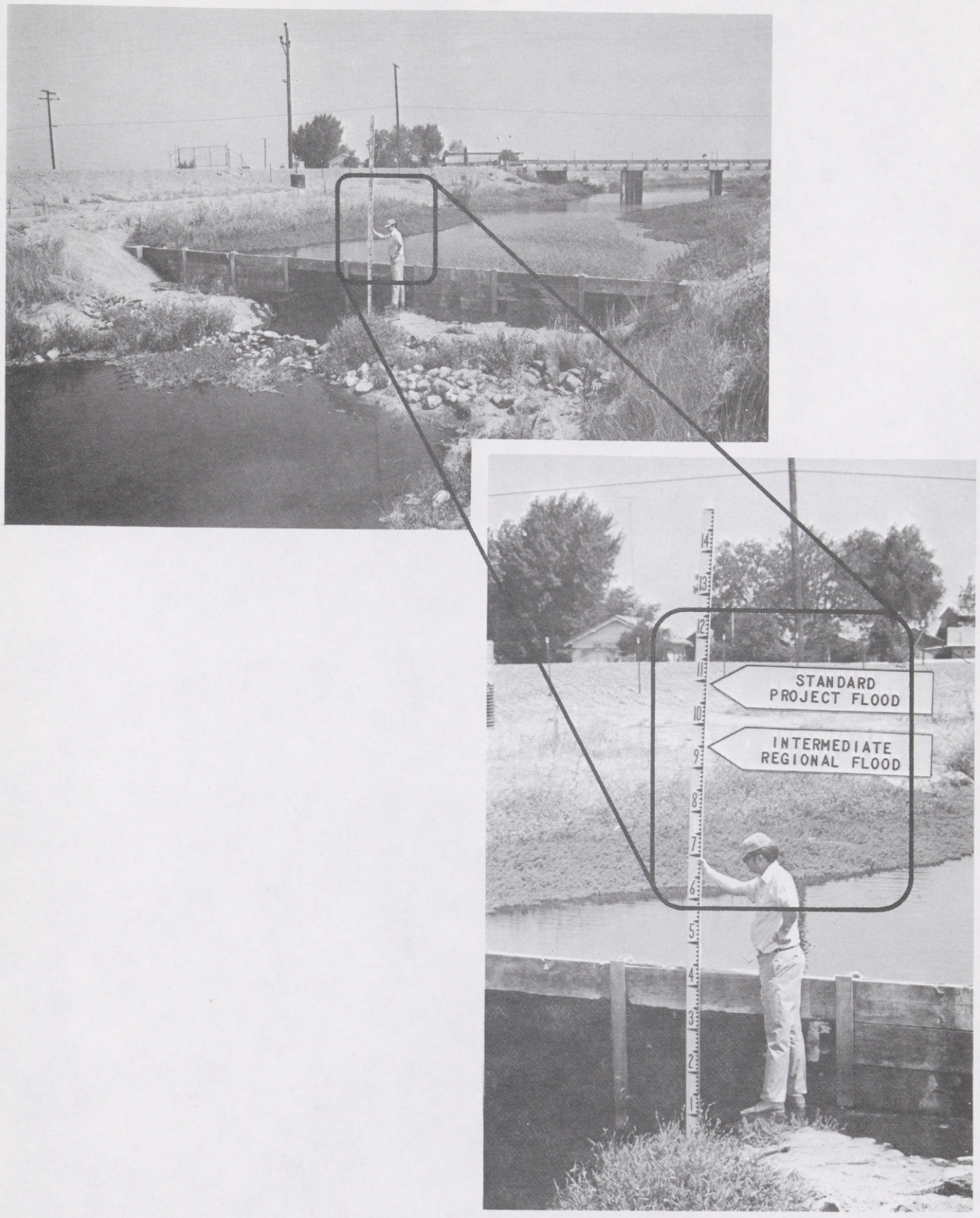


Figure 23 - Future flood heights on Paddy Creek at an irrigation diversion structure just downstream from Harney Lane.

GLOSSARY

Backwater Effect. The rise in surface elevation of flowing water upstream from and as a result of an obstruction to flow.

Cloudburst. A sudden and extremely heavy downpour of rain that is small in areal extent; of short duration; and may be accompanied by lightning, thunder, and strong gusts of wind.

Flood. An overflow of water onto lands that are used or usable by man and not normally covered by water. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean.

Normally, a "flood" is considered as any temporary rise in streamflow or stage (but not the ponding of surface water) that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow in land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of groundwater coincident with increased streamflow, and other problems.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest, i.e., the maximum stage or elevation reached by the floodflow.

Flood Plain. The relatively flat area or lowlands adjoining a river, stream, watercourse, ocean, or lake, which have been or may be covered by floodwater.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Floodway. The channel of the stream and that portion of the flood plain that would be used to carry floodflows.

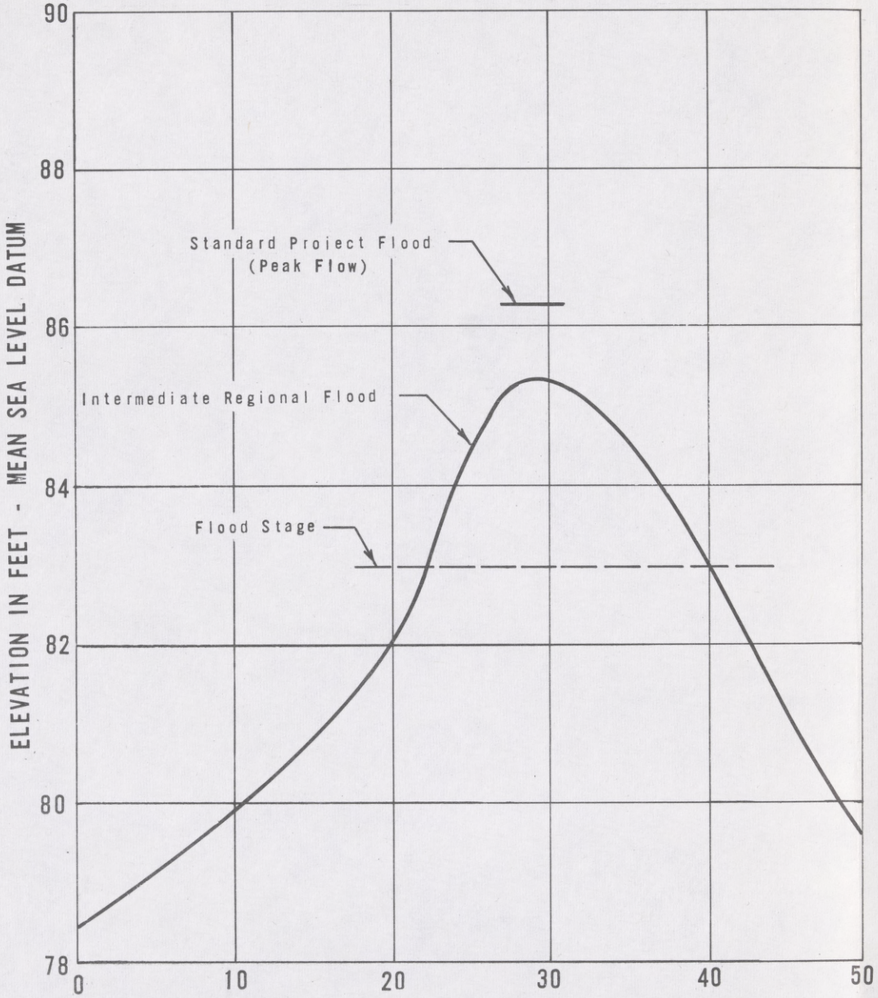
Freeboard. The vertical distance from the top of a levee down to the water when it is flowing at the maximum level for which the levee was designed. Freeboard is essentially a built-in safety factor.

Hydrograph. A graph of time *vs* flow or stage at a given location along a stream.

Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years although it may occur in any year.

Sheet Flow. Broad, shallow overland floodflows generally less than 2 feet deep.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations.



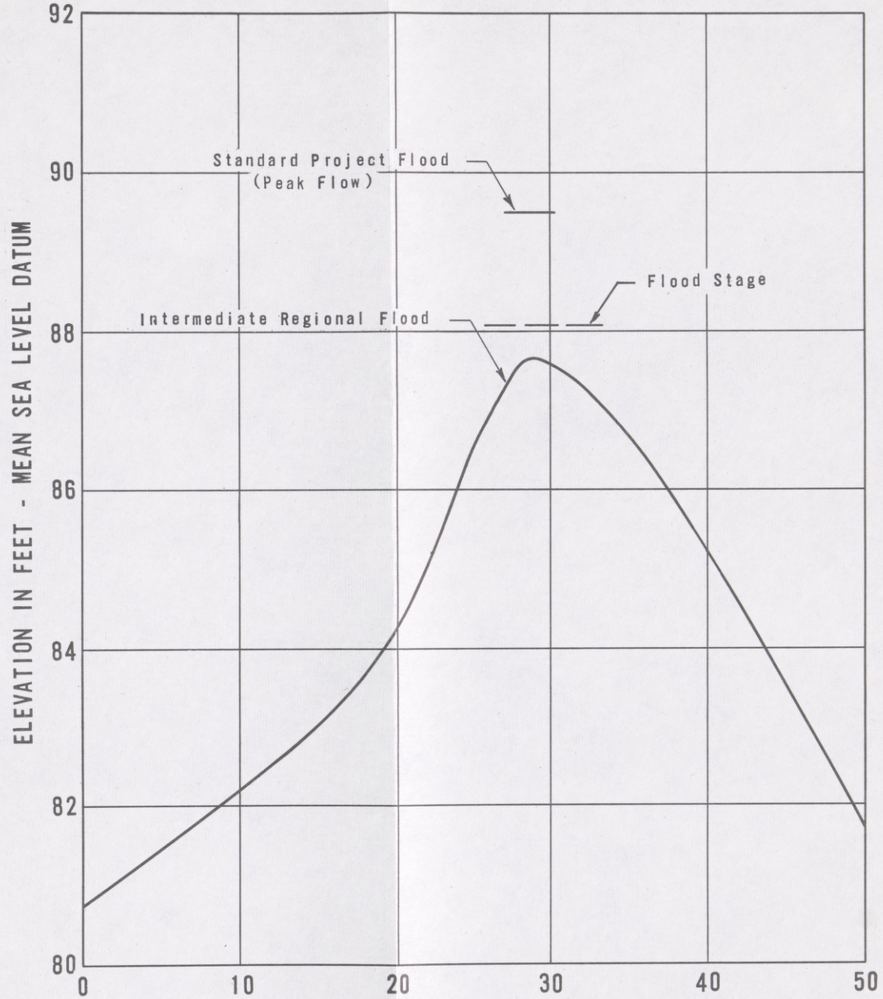
MILE 16.40

NOTES

Hydrographs are based on computed data.

Flood Stage is the beginning of overbank flow.

Flood Stage at Mile 16.40 corresponds to a water surface elevation of 85 feet, mean sea level datum, at Jack Tone Road.



JACK TONE ROAD
(DOWNSTREAM FACE)

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

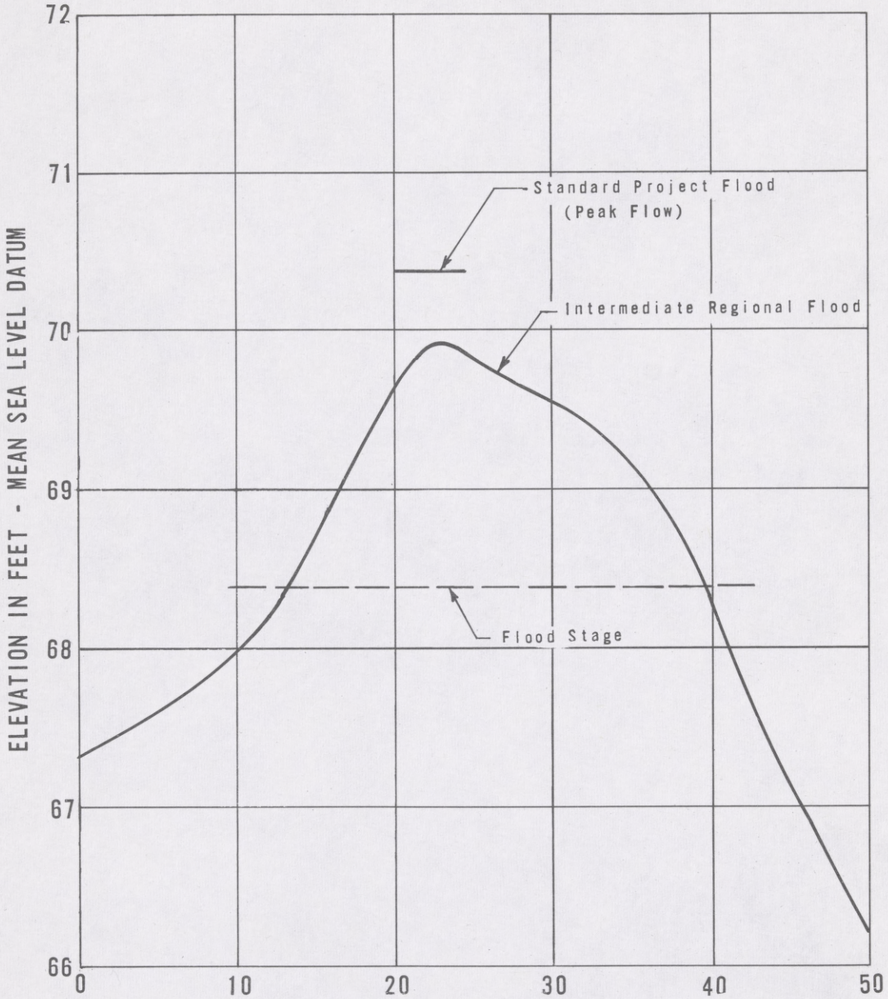
STAGE HYDROGRAPH

INTERMEDIATE REGIONAL FLOOD

BEAR CREEK

JANUARY 1974

PLATE 2



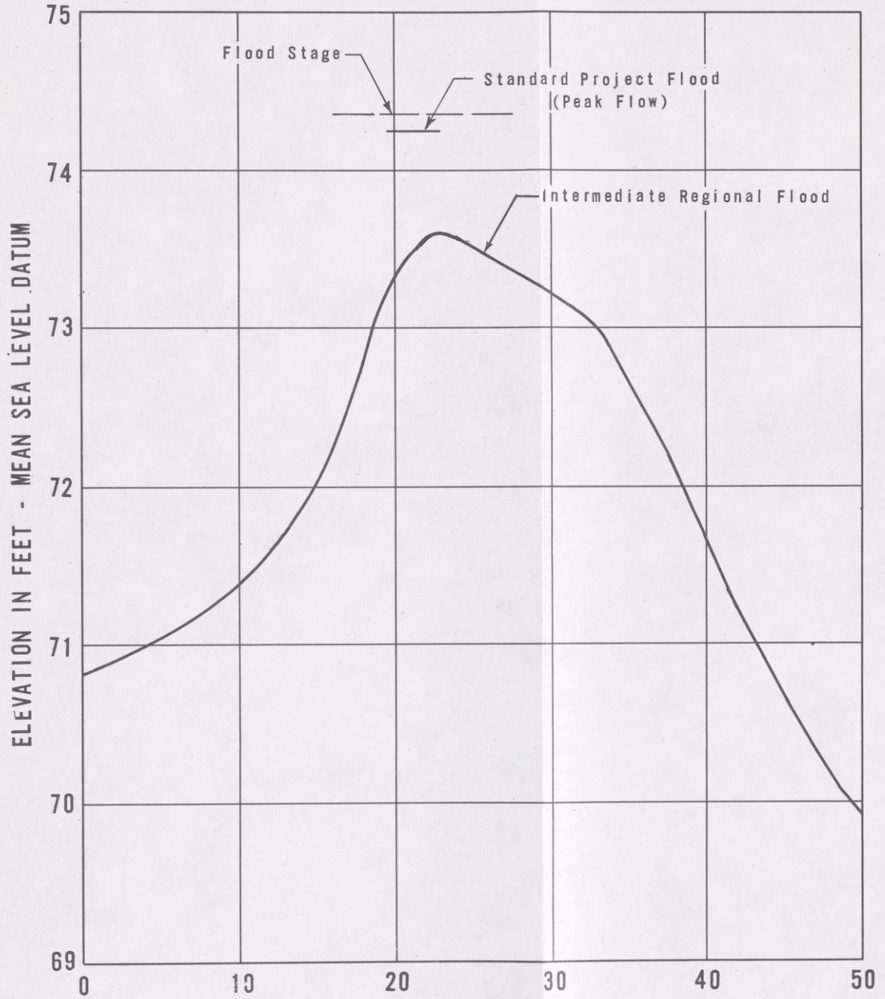
MILE 2.80

NOTES

Hydrographs are based on computed data.

Flood Stage is beginning of overbank flow.

Flood Stage at Mile 2.80 corresponds to a water surface elevation of 72 feet, mean sea level datum, at Jack Tone Road.



JACK TONE ROAD
(DOWNSTREAM FACE)

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

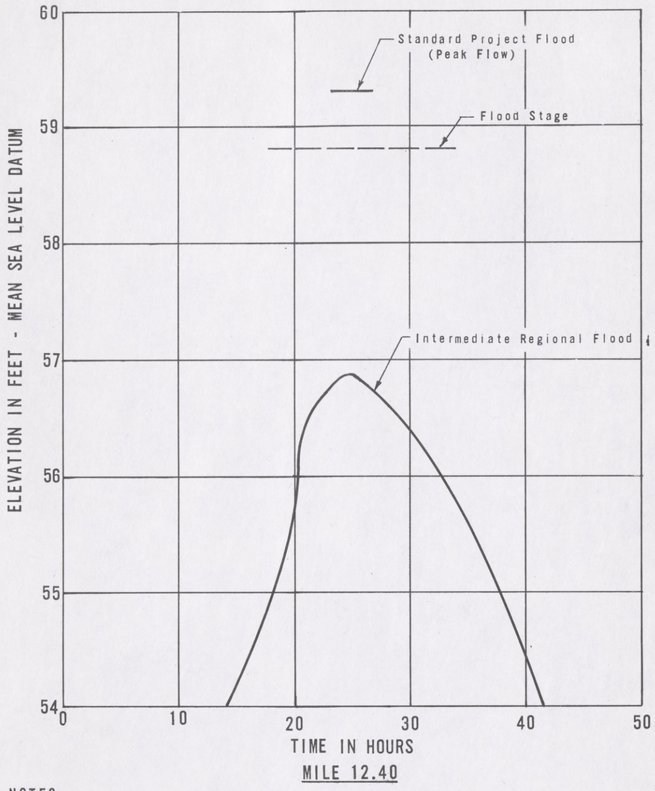
NORTHEAST STREAM GROUP
STOCKTON, CALIFORNIA

STAGE HYDROGRAPH

INTERMEDIATE REGIONAL FLOOD

MOSHER CREEK
JANUARY 1974

PLATE 3



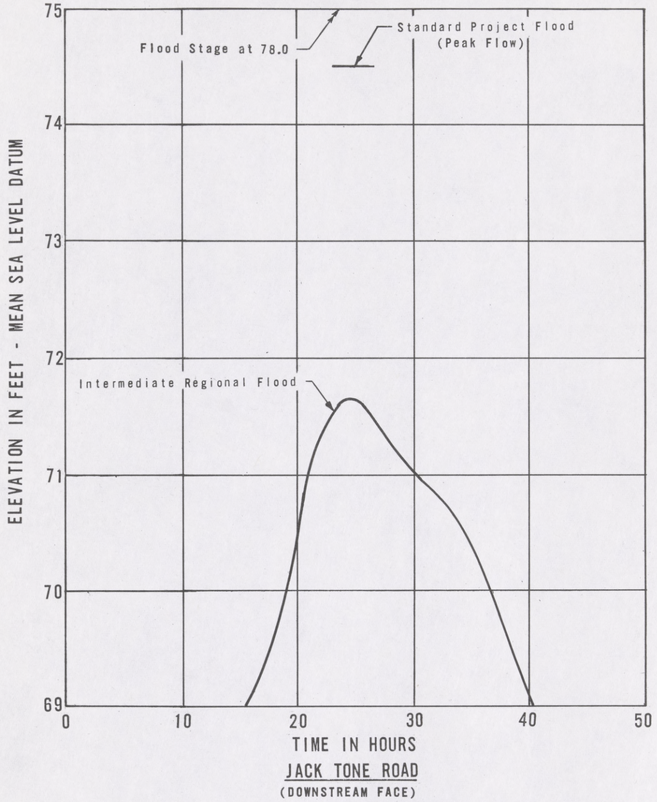
MILE 12.40

NOTES

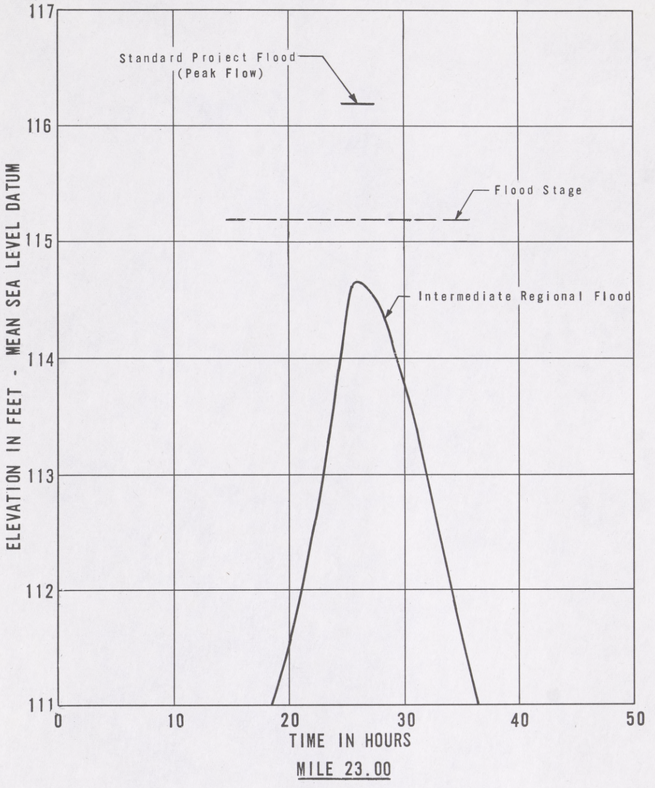
Hydrographs are based on computed data.

Flood Stage is beginning of overbank flow.

Flood Stage at Mile 12.40 corresponds to a water surface elevation of 73 feet, mean sea level datum, at Jack Tone Road.



JACK TONE ROAD
(DOWNSTREAM FACE)



MILE 23.00

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

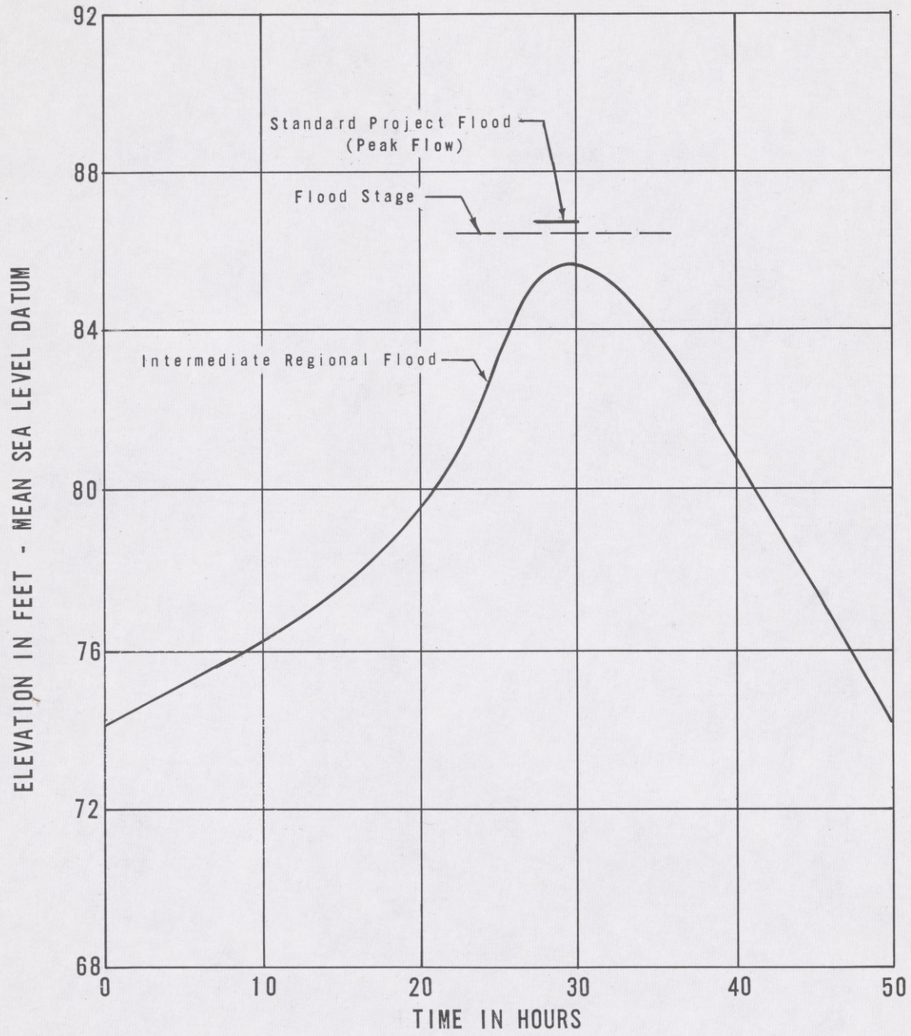
STAGE HYDROGRAPH

INTERMEDIATE REGIONAL FLOOD

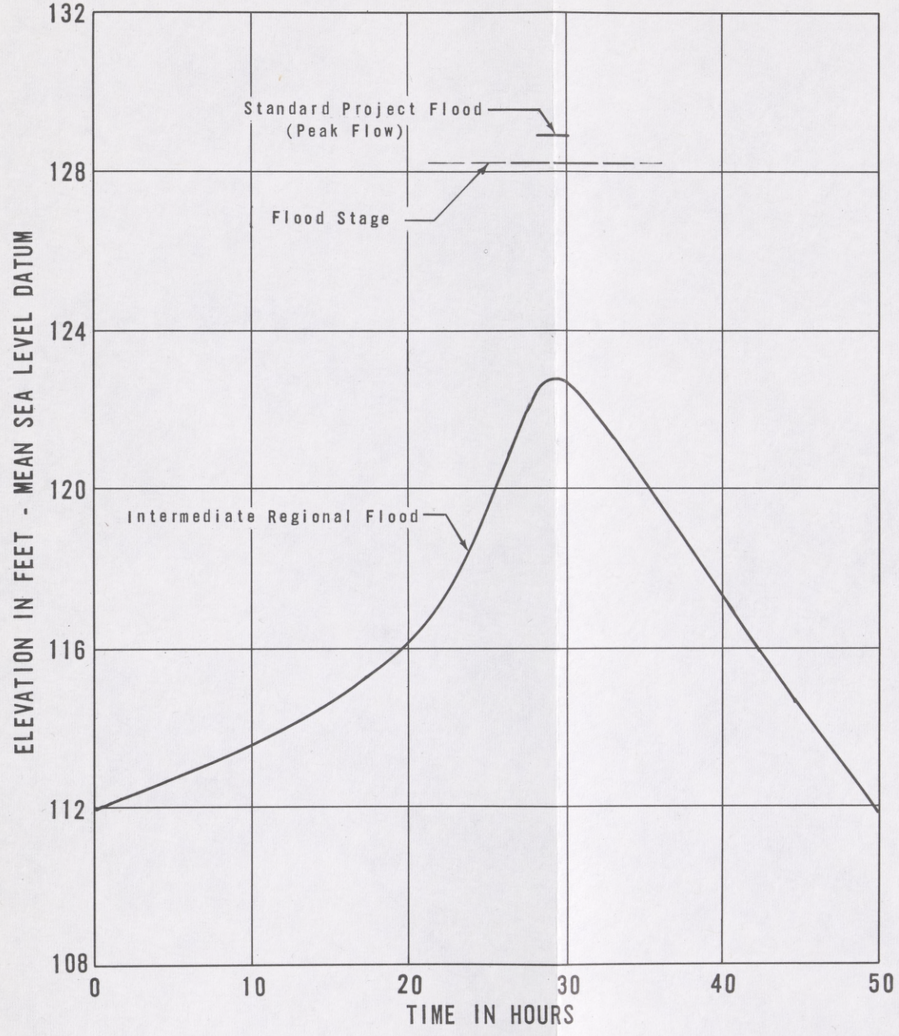
CALAVERAS RIVER

JANUARY 1974

PLATE 4



MILE 12.10



ESCALON - BELLOTA ROAD
(DOWNSTREAM FACE)

NOTES

Hydrographs are based on computed data.

Flood Stage is beginning of overbank flow.

Flood Stage at Mile 12.10 corresponds to a water surface elevation of 122 feet, mean sea level datum, at Escalon-Bellota Road.

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NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

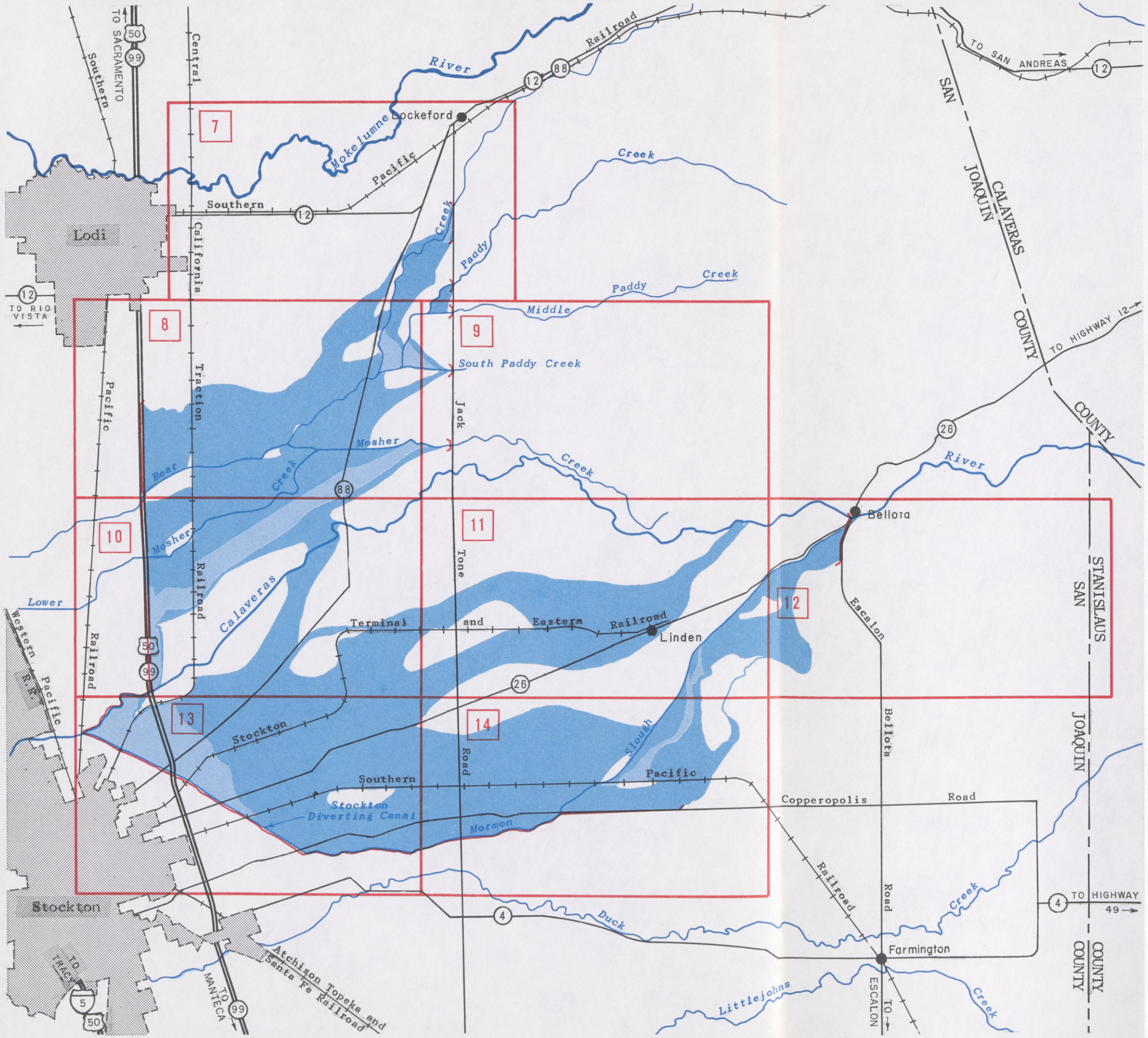
STAGE HYDROGRAPH

INTERMEDIATE REGIONAL FLOOD

MORMON SLOUGH

JANUARY 1974

PLATE 5



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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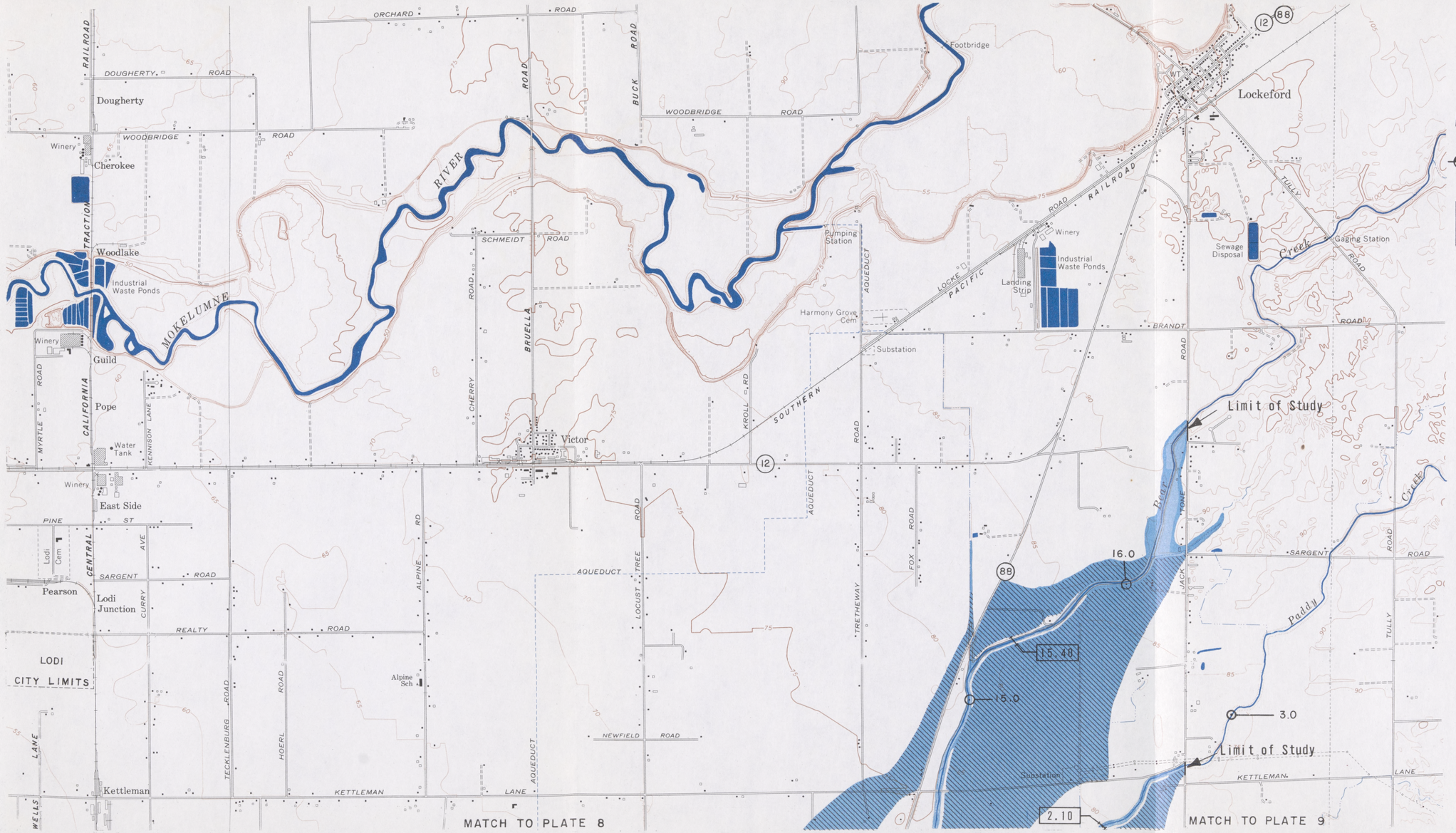
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

INDEX MAP-FLOODED AREAS

JANUARY 1974

PLATE 6



LEGEND

Overflow Limits

- Low Water Channel
- Intermediate Regional Flood
- Standard Project Flood

Area Subject to Sheet Flow

- Standard Project Flood

(Limits of Flooding are approximate)

2.10 — Cross Section

15.0 — Distance in miles upstream from mouth

(12) — State Highway

NOTES

Map based on U.S.G.S. 7.5- min quadrangle sheets Lockeford 1968 and Waterloo 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

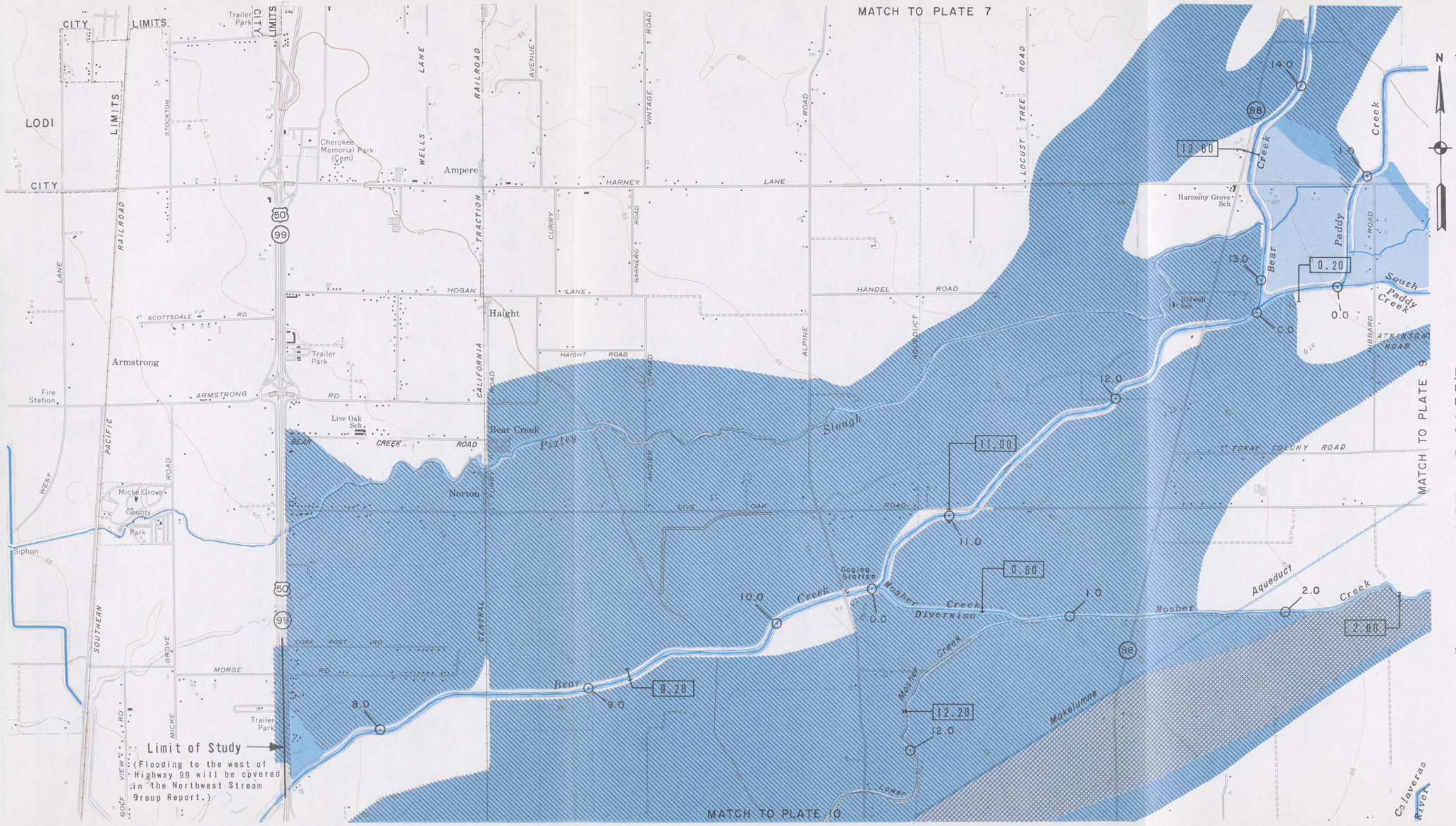
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 7



LEGEND

Overflow Limits

Low Water Channel | Intermediate Regional Flood | Standard Project Flood

Area Subject to Sheet Flow

Standard Project Flood Only

Standard Project and Intermediate Regional Floods

(Limits of Flooding are approximate)

0.20 — Cross Section

0.0 — Distance in miles upstream from mouth

50 — U.S. Highway

88 — State Highway

NOTES

Map based on U.S.G.S. 7.5-min. quadrangle sheets Lodi South 1968 and Waterloo 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

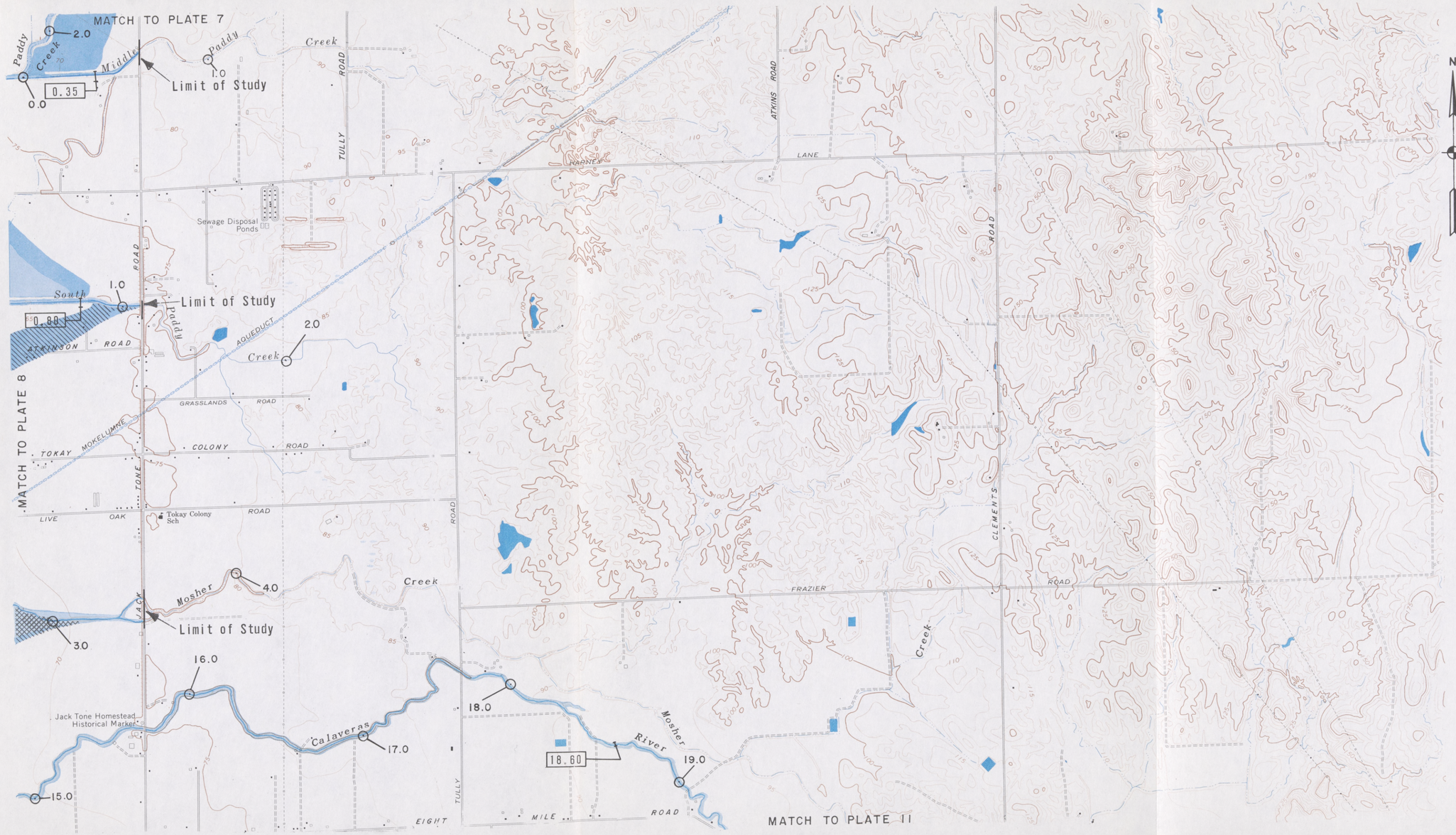
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 8



LEGEND

Overflow Limits

- Low Water Channel
- Intermediate Regional Flood
- Standard Project Flood

Area Subject to Sheet Flow

- Standard Project Flood Only
- Standard Project and Intermediate Regional Floods

(Limits of Flooding are approximate)

0.35 — Cross Section

0.0 — Distance in miles upstream from mouth

NOTES

Map based on U.S.G.S. 7.5-min quadrangle sheets Linden 1968 and Waterloo 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

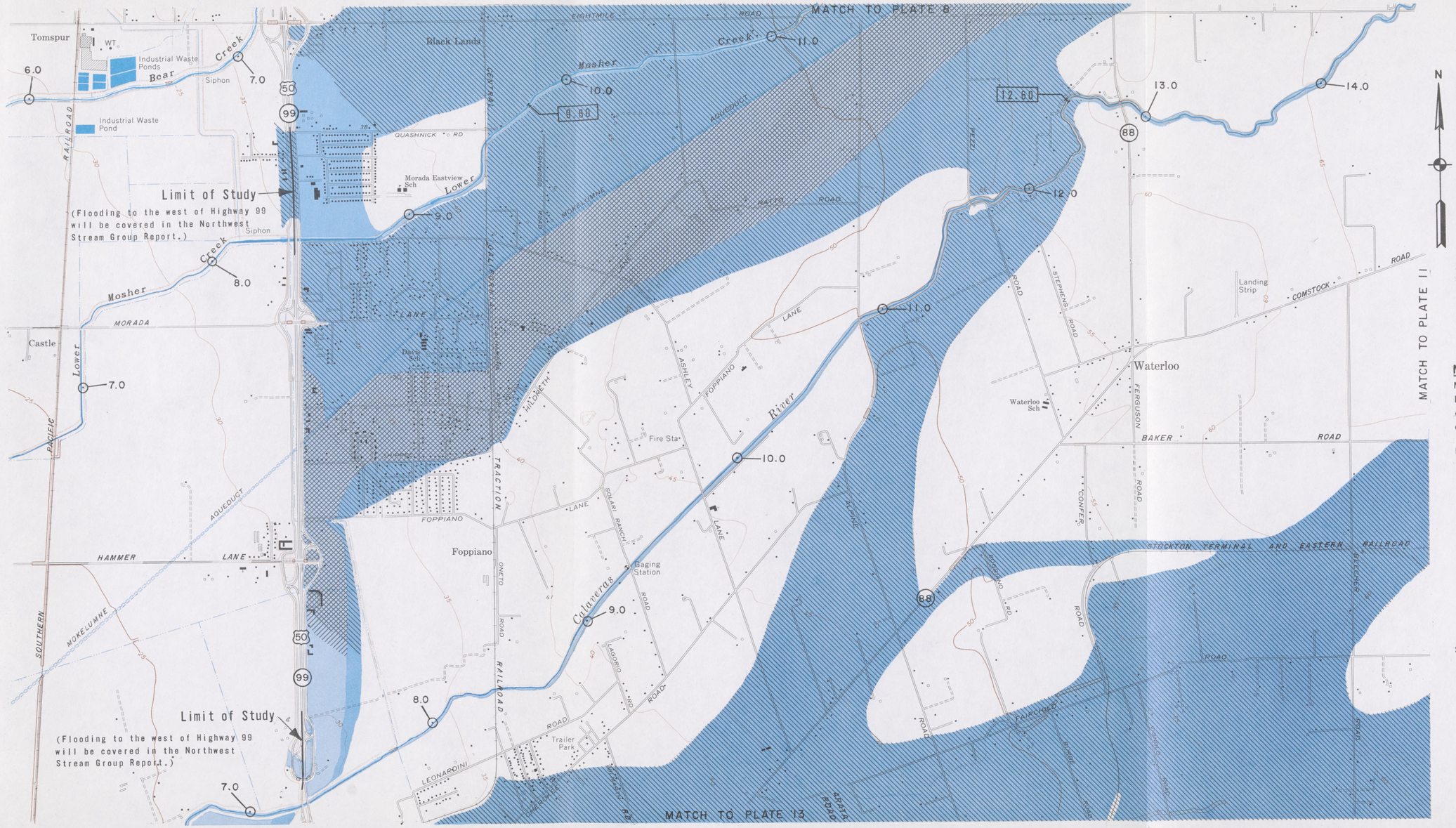
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 9



LEGEND

Overflow Limits

- Low Water Channel
- Intermediate Regional Flood
- Standard Project Flood

Area Subject to Sheet Flow

- Standard Project Flood Only
- Standard Project and Intermediate Regional Floods
- Intermediate Regional Flood Only

(Limits of Flooding are Approximate)

- 9.80 — Cross Section
- 6.0 — Distance in miles upstream from mouth
- 50 — U.S. Highway
- 88 — State Highway

NOTES

Map based on U.S.G.S. 7.5-min. quadrangle sheets Lodi South 1968 and Waterloo 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

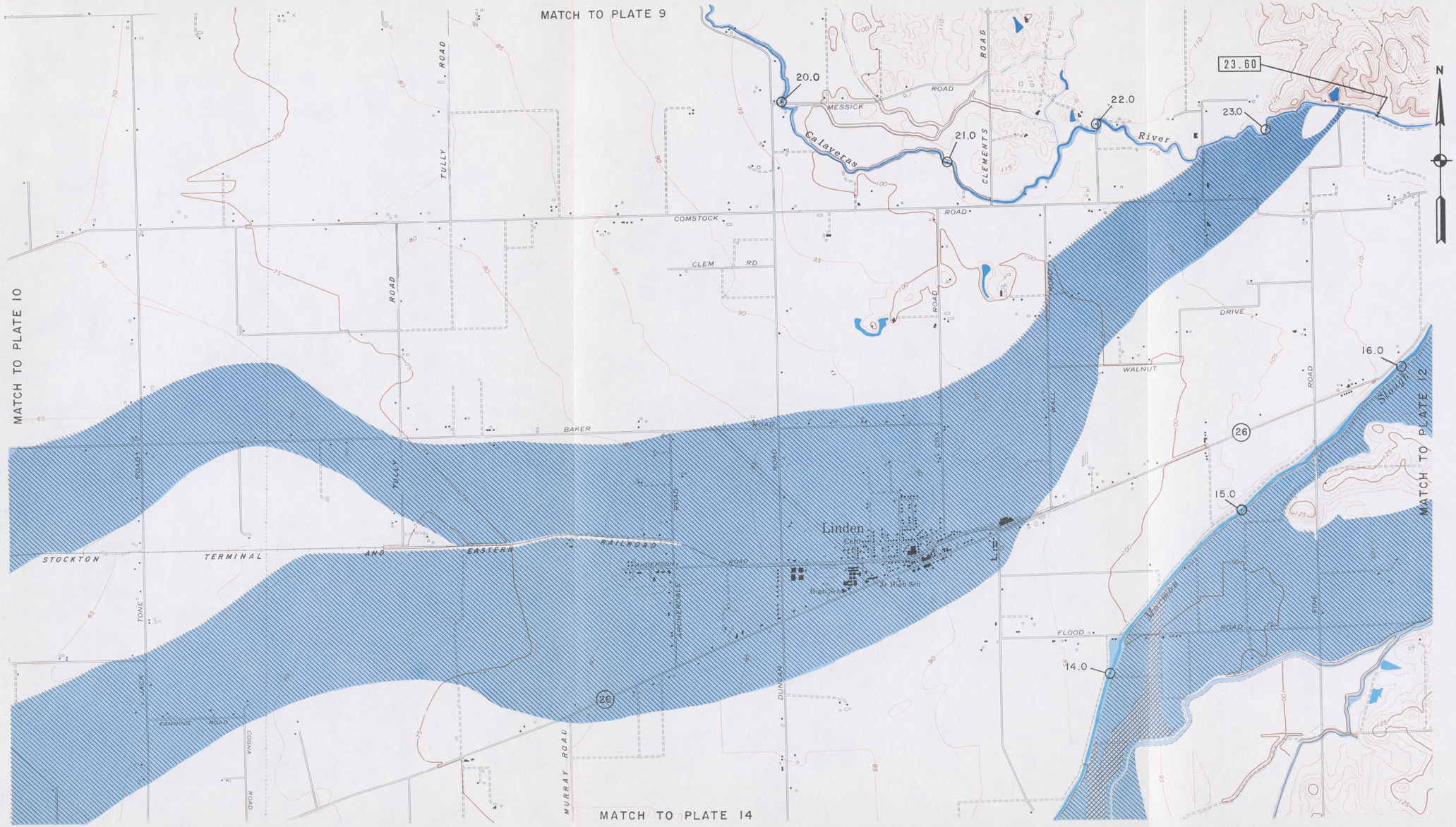
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 10



LEGEND

Overflow Limits

Low Water Channel | Intermediate Regional Flood | Standard Project Flood

Area Subject to Sheet Flow

- Standard Project Flood Only
- Standard Project and Intermediate Regional Floods

(Limits of Flooding are approximate)

- 23.60 — Cross Section
- 14.0 — Distance in miles upstream from mouth
- (26) — State Highway

NOTES

Map based on U.S.G.S. 7.5-min quadrangle sheets Linden 1968 and Waterloo 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

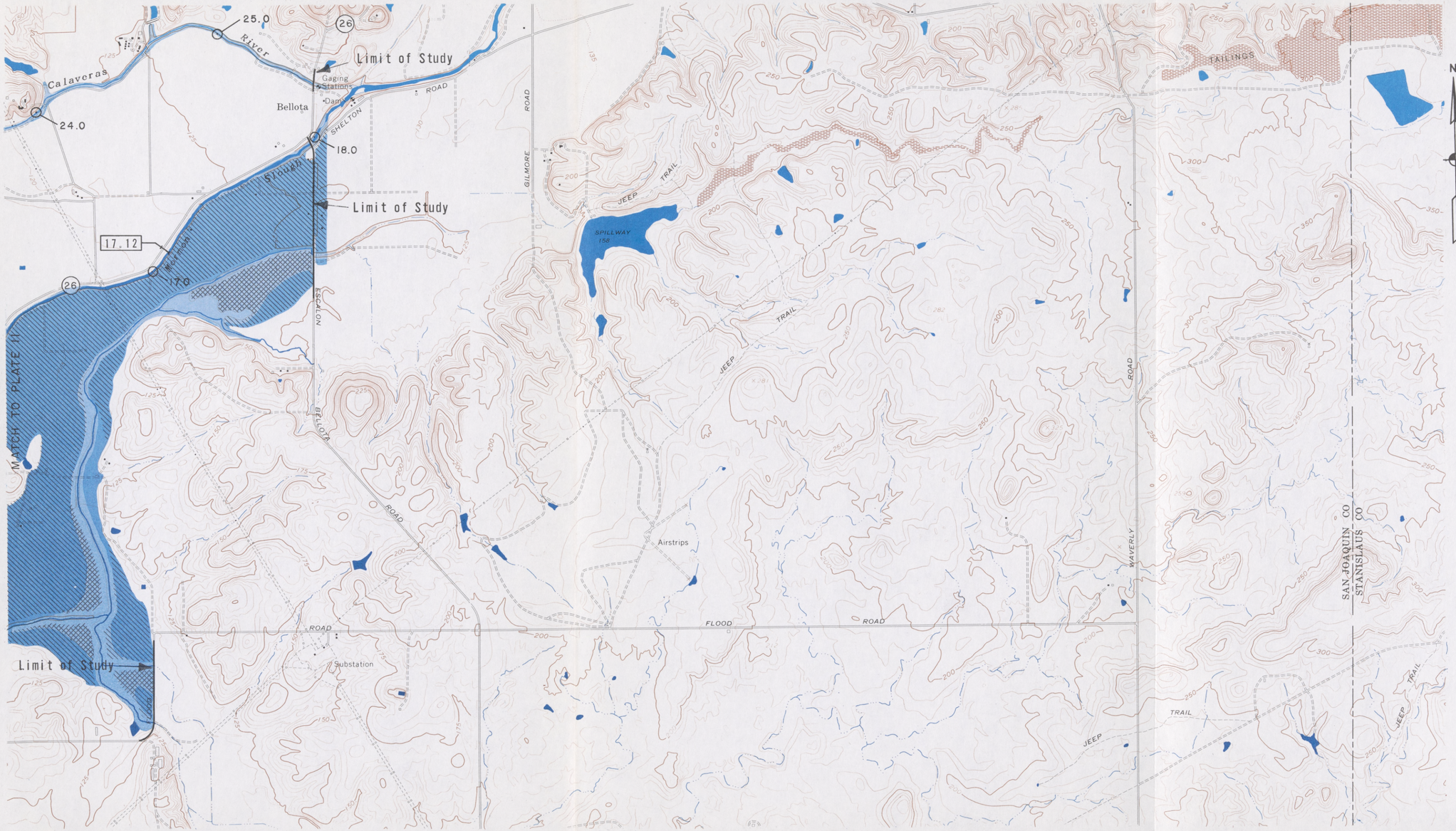
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 11



LEGEND

Overflow Limits

Low Water Channel

Intermediate Regional Flood

Standard Project Flood

Area Subject to Sheet Flow

Standard Project Flood Only

Standard Project and Intermediate Regional Floods

(Limits of Flooding are approximate)

17.12 Cross Section

17.0 Distance in miles upstream from mouth

(26) State Highway

NOTES

Map based on U.S.G.S. 7.5 - min quadrangle sheets Linden 1968 and Valley Springs SW 1962. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 AND 10 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

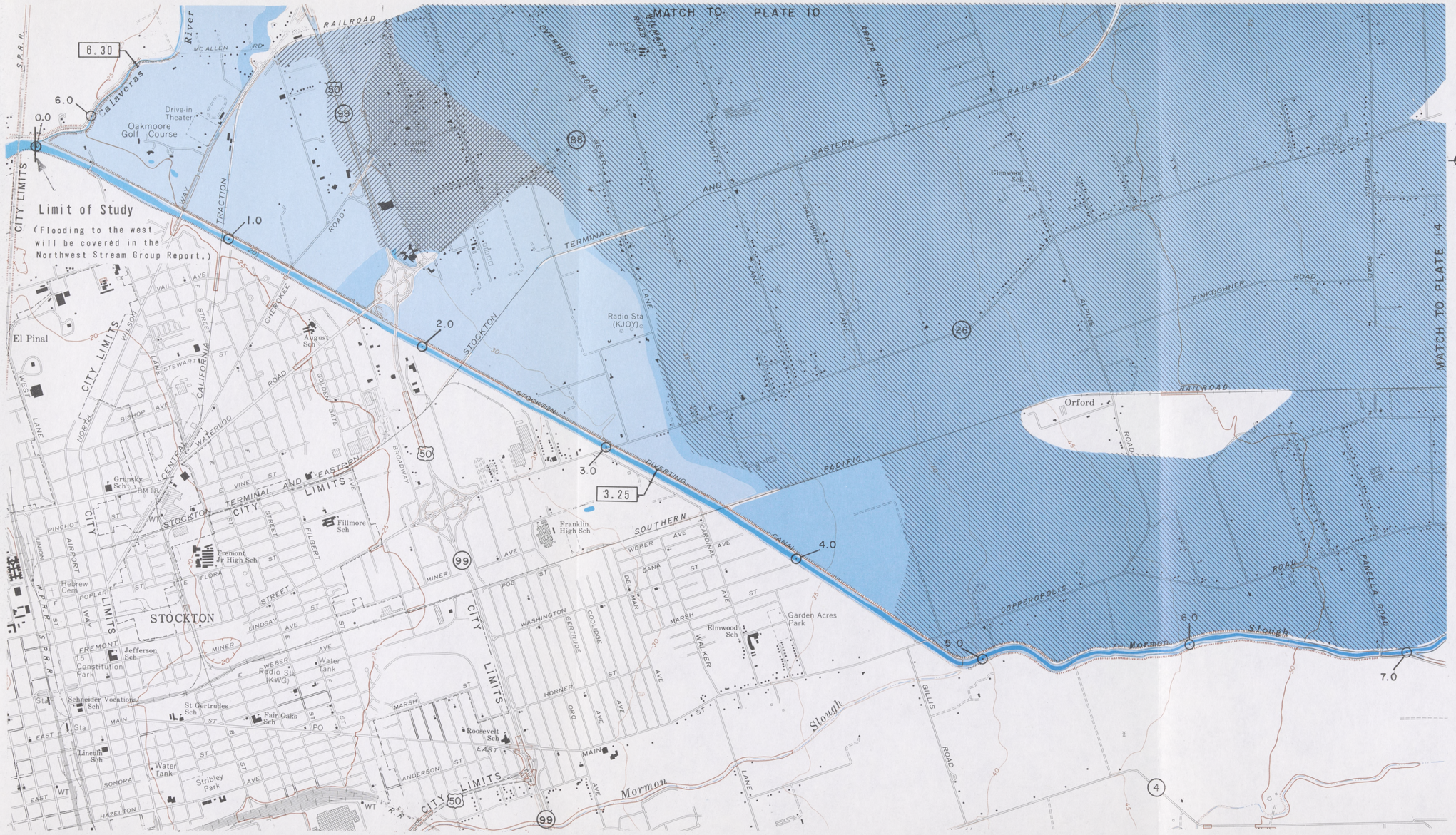
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 12



LEGEND

Overflow Limits

Low Water Channel | Intermediate Regional Flood | Standard Project Flood

Area Subject to Sheet Flow

- Standard Project Flood Only
- Standard Project and Intermediate Regional Floods
- Intermediate Regional Flood Only

(Limits of Flooding are Approximate)

- 3.25 — Cross Section
- 0.0 — Distance in miles upstream from mouth
- (50) U.S. Highway
- (99) State Highway

NOTES

Map based on U.S.G.S. 7.5-min. quadrangle sheets, Lodi South 1968, Stockton East 1968, Stockton West 1968, and Waterloo 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

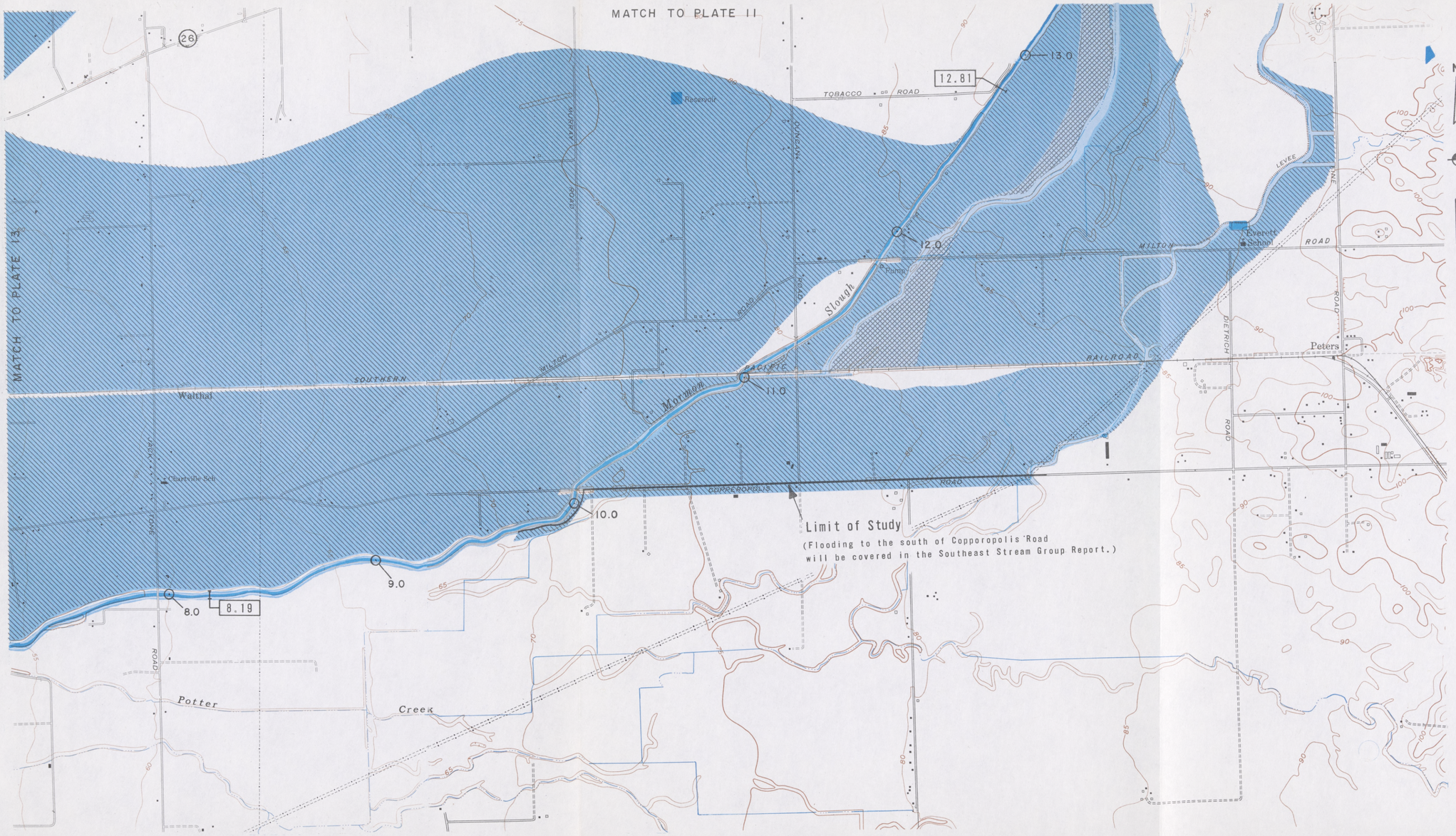
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 13



LEGEND

Overflow Limits

Low Water Channel | Intermediate Regional Flood | Standard Project Flood

Area Subject to Sheet Flow

- Standard Project Flood Only
- Standard Project and Intermediate Regional Floods

(Limits of Flooding are approximate)

8.19 — Cross Section

8.0 — Distance in miles upstream from mouth

26 — State Highway

NOTES

Map based on U.S.G.S. 7.5-min quadrangle sheets, Waterloo 1968, Linden 1968, Stockton East 1968, and Peters photorevised 1968. Minor additions and adjustments made by Corps of Engineers.

Elevations shown are based on Mean Sea Level Datum.

Limits of overflow indicated may vary from actual locations on the ground because of accuracy of available topography.

Areas outside the floodway may be subject to flooding from local runoff.

SCALE IN FEET

1000 0 2000 4000

CONTOUR INTERVAL 5 FEET

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

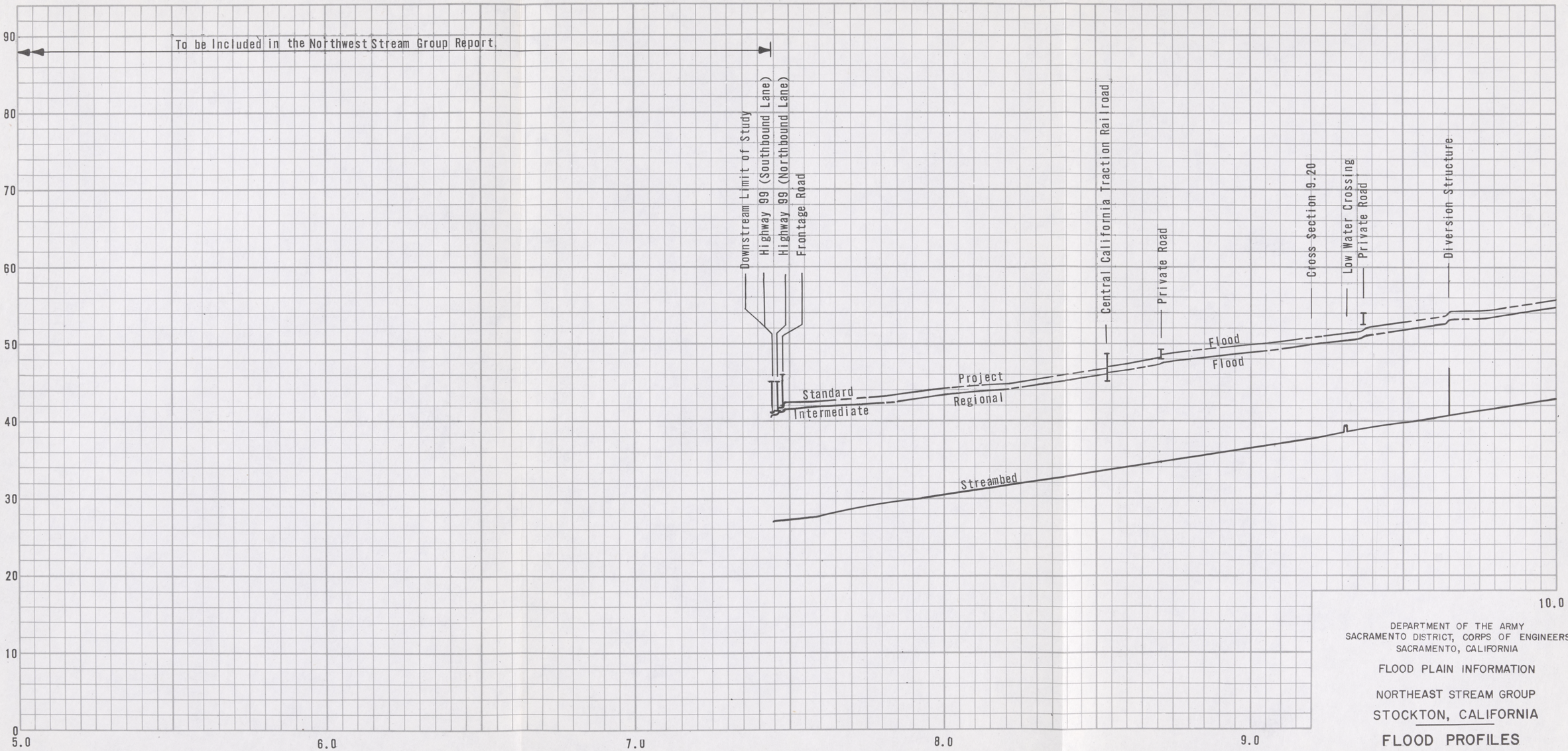
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOODED AREAS

JANUARY 1974

PLATE 14



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

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PLATE 15

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOOD PROFILES
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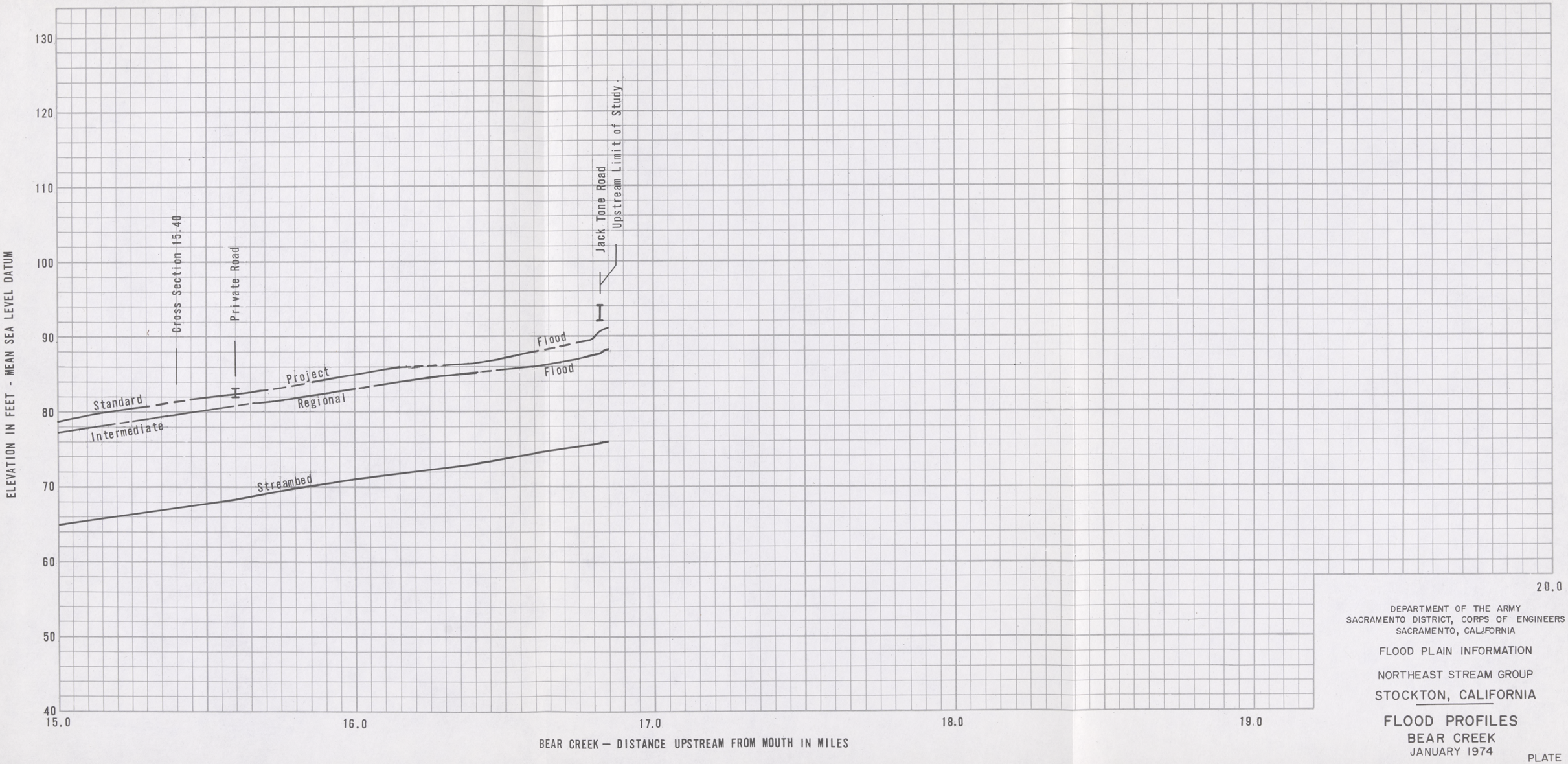
JANUARY 1974

PLATE 16



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

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STOCKTON, CALIFORNIA

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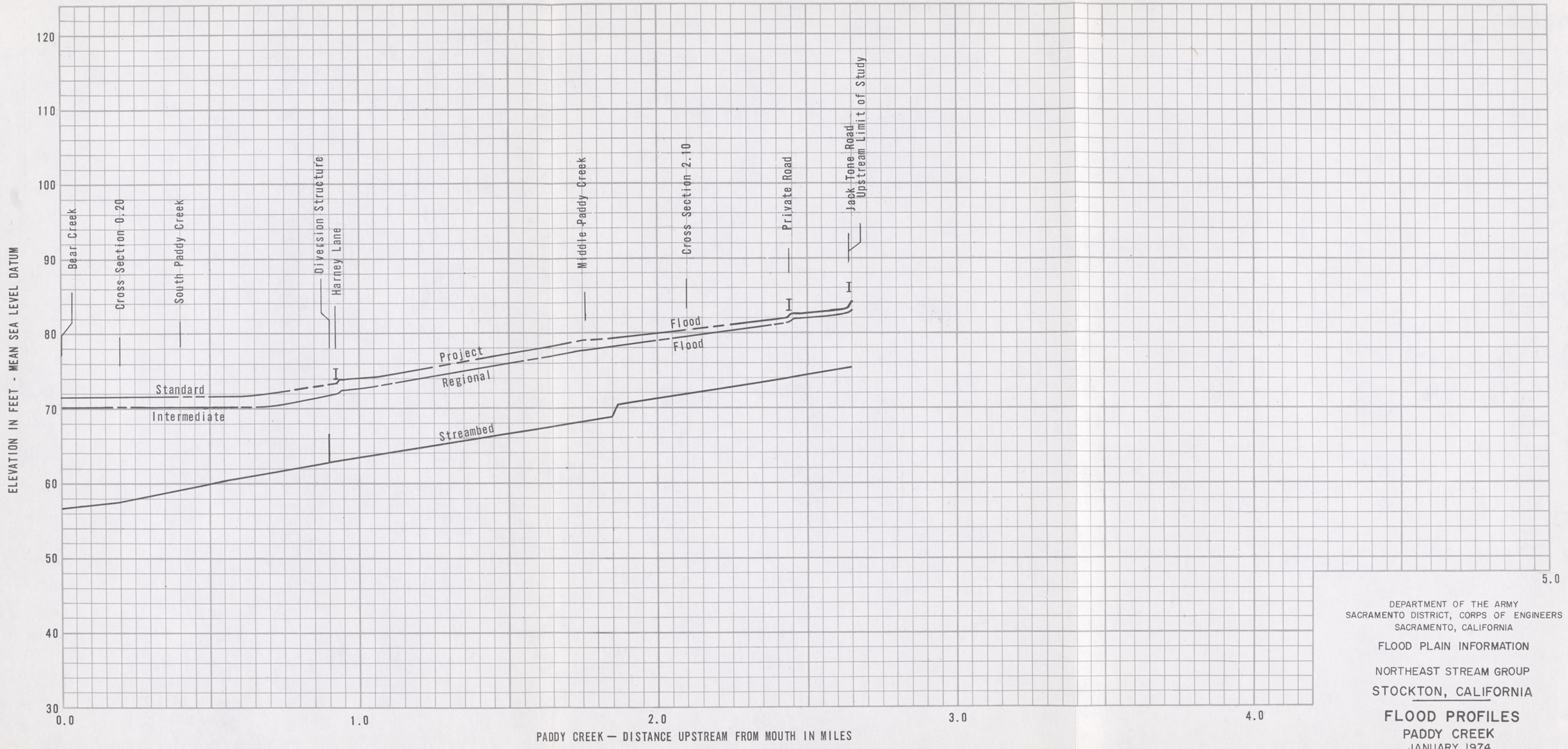
PLATE 17



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

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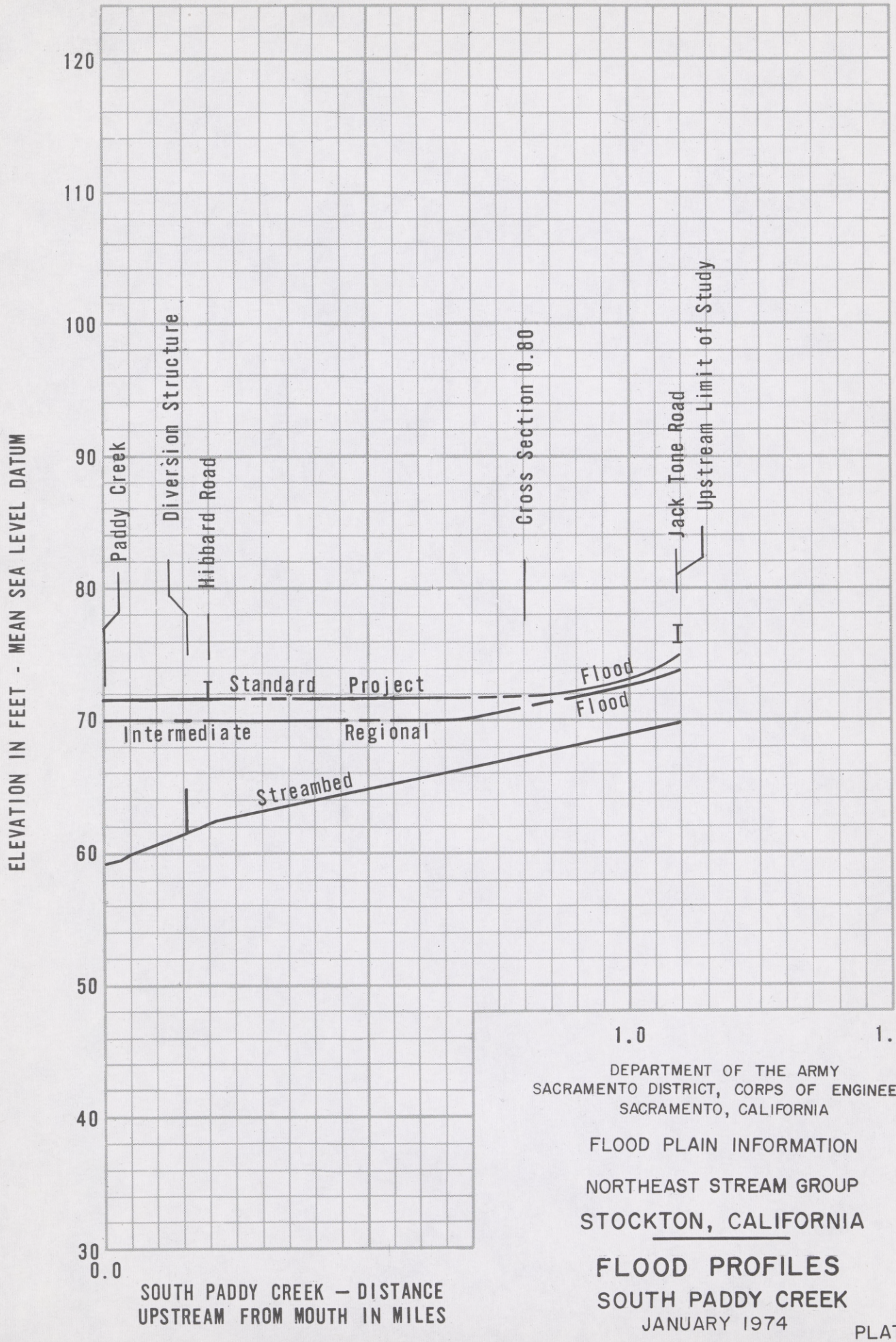
FLOOD PROFILES

PADDY CREEK

JANUARY 1974

PLATE 18



DEPARTMENT OF THE ARMY
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FLOOD PLAIN INFORMATION

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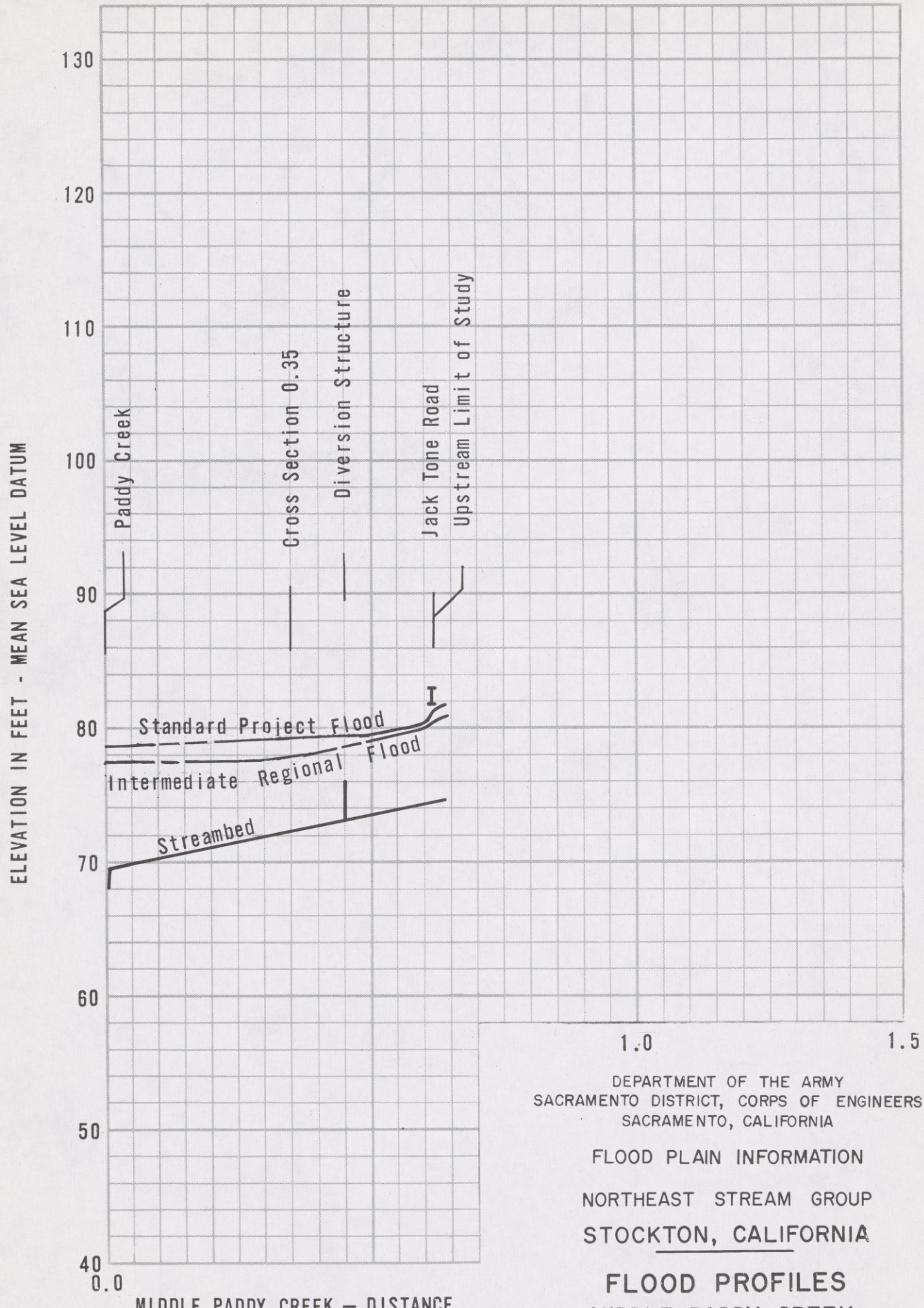
PLATE 19



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

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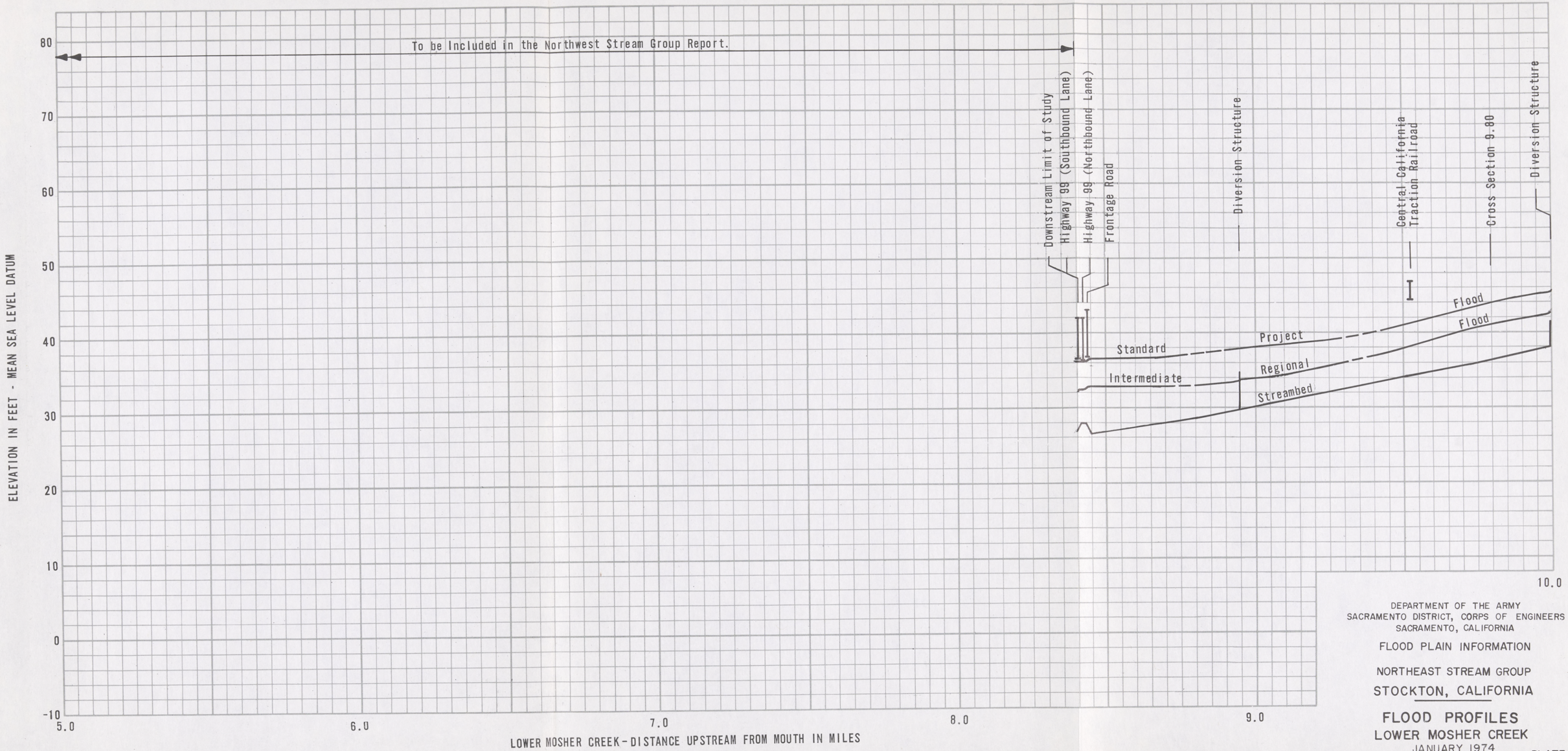

DEPARTMENT OF THE ARMY
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

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FLOOD PROFILES
LOWER MOSHER CREEK

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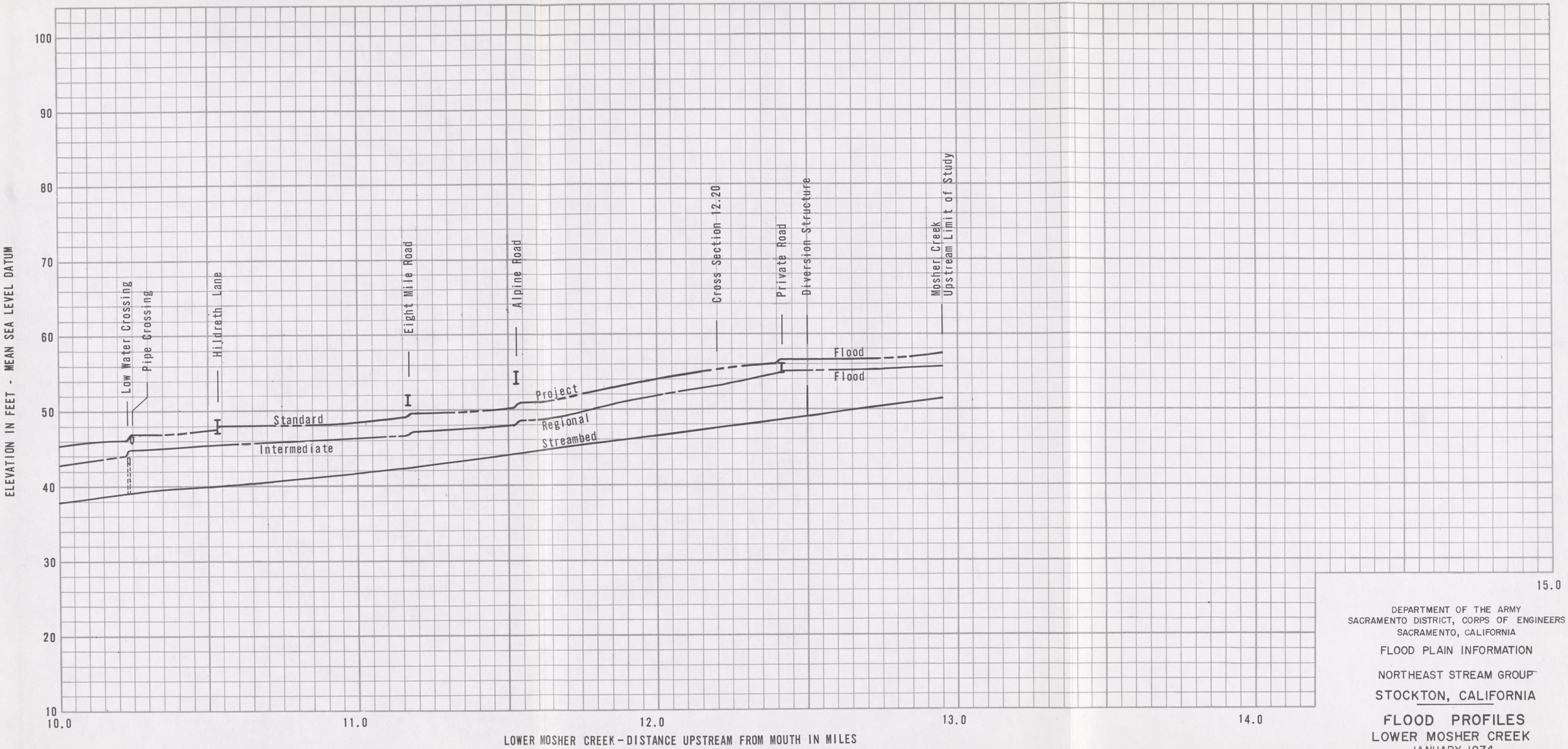
PLATE 21



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

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FLOOD PROFILES
LOWER MOSHER CREEK

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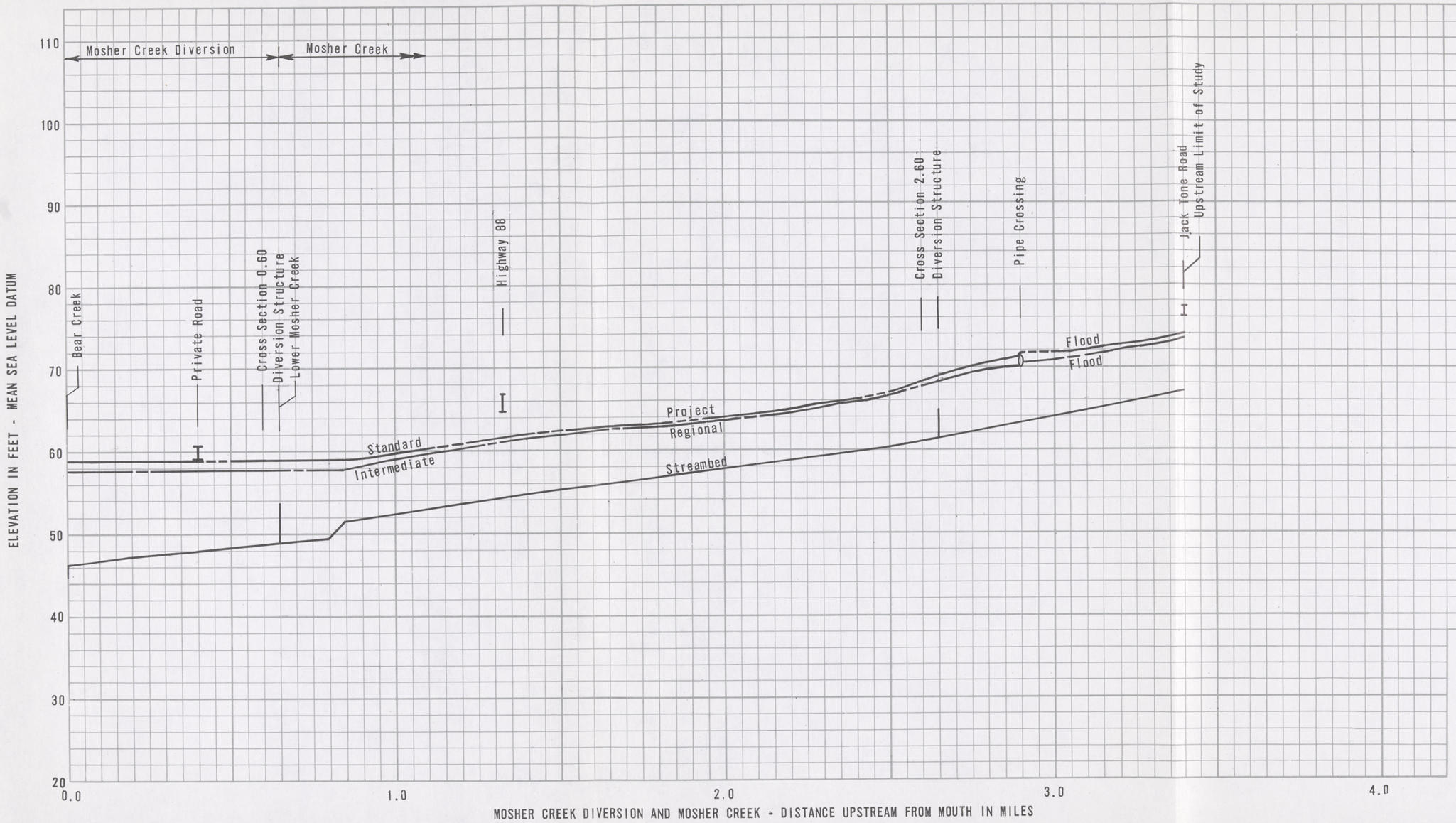
PLATE 22



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

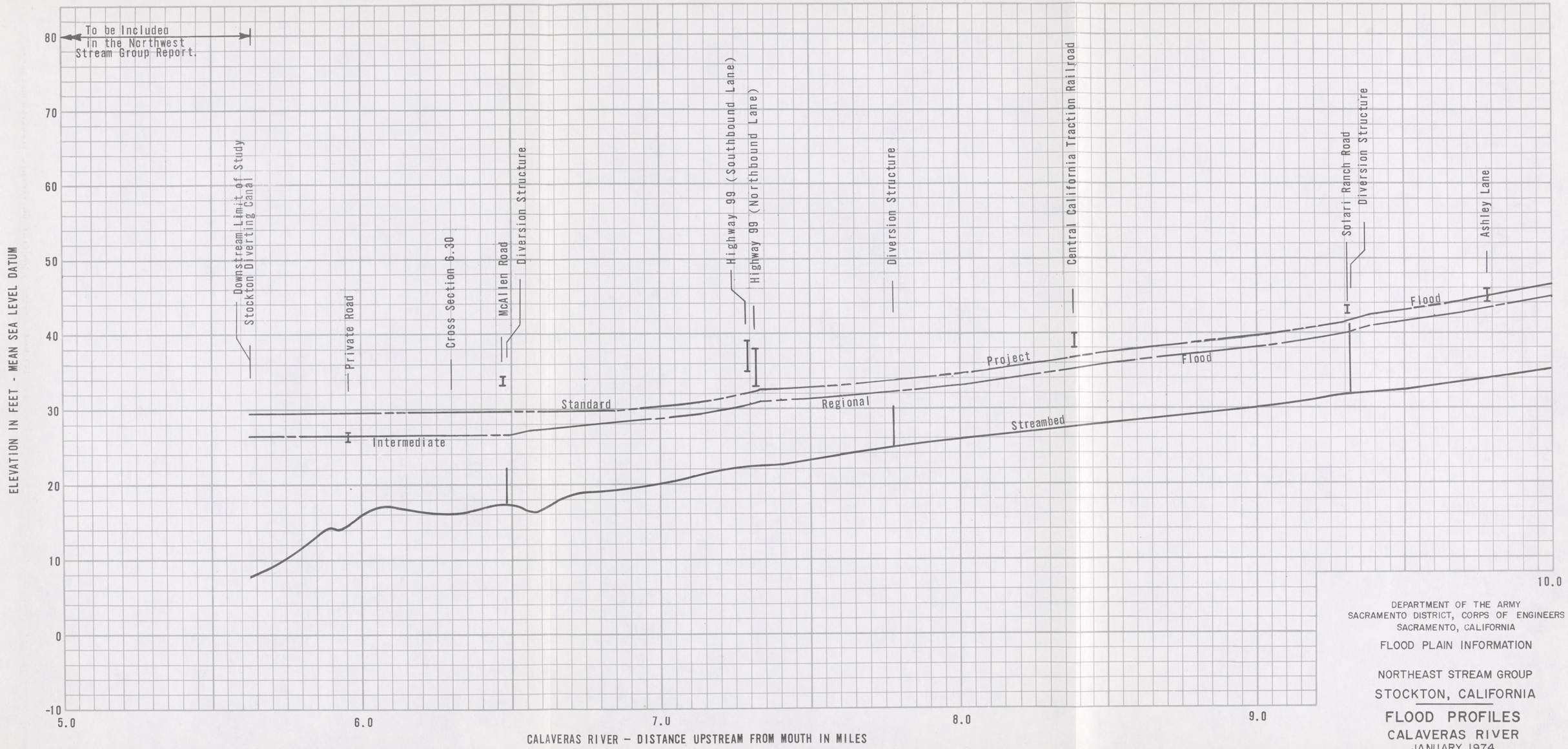
NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOOD PROFILES
MOSHER CREEK DIVERSION
AND MOSHER CREEK

JANUARY 1974

PLATE 23



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP
STOCKTON, CALIFORNIA

FLOOD PROFILES
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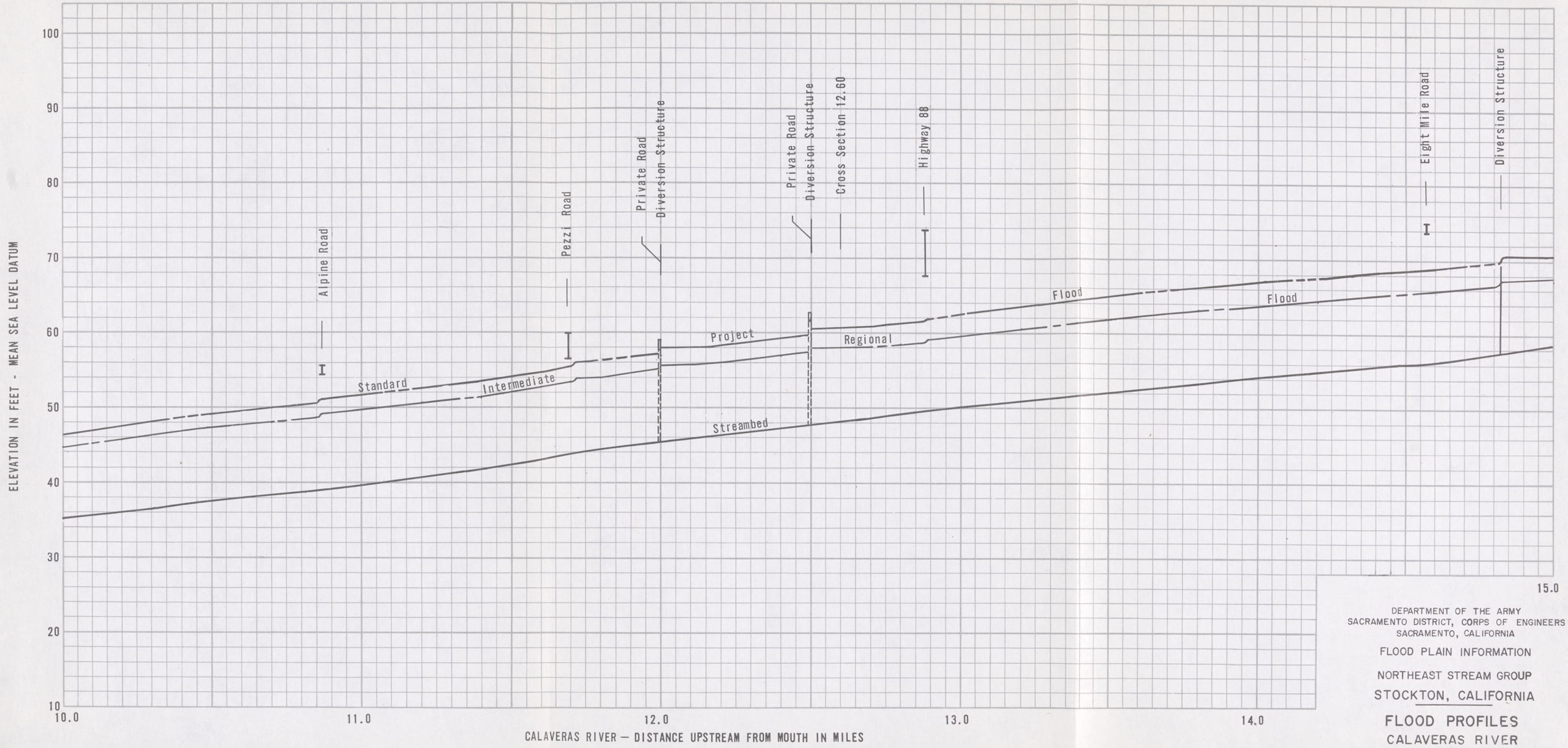
JANUARY 1974

PLATE 24



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
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FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOOD PROFILES

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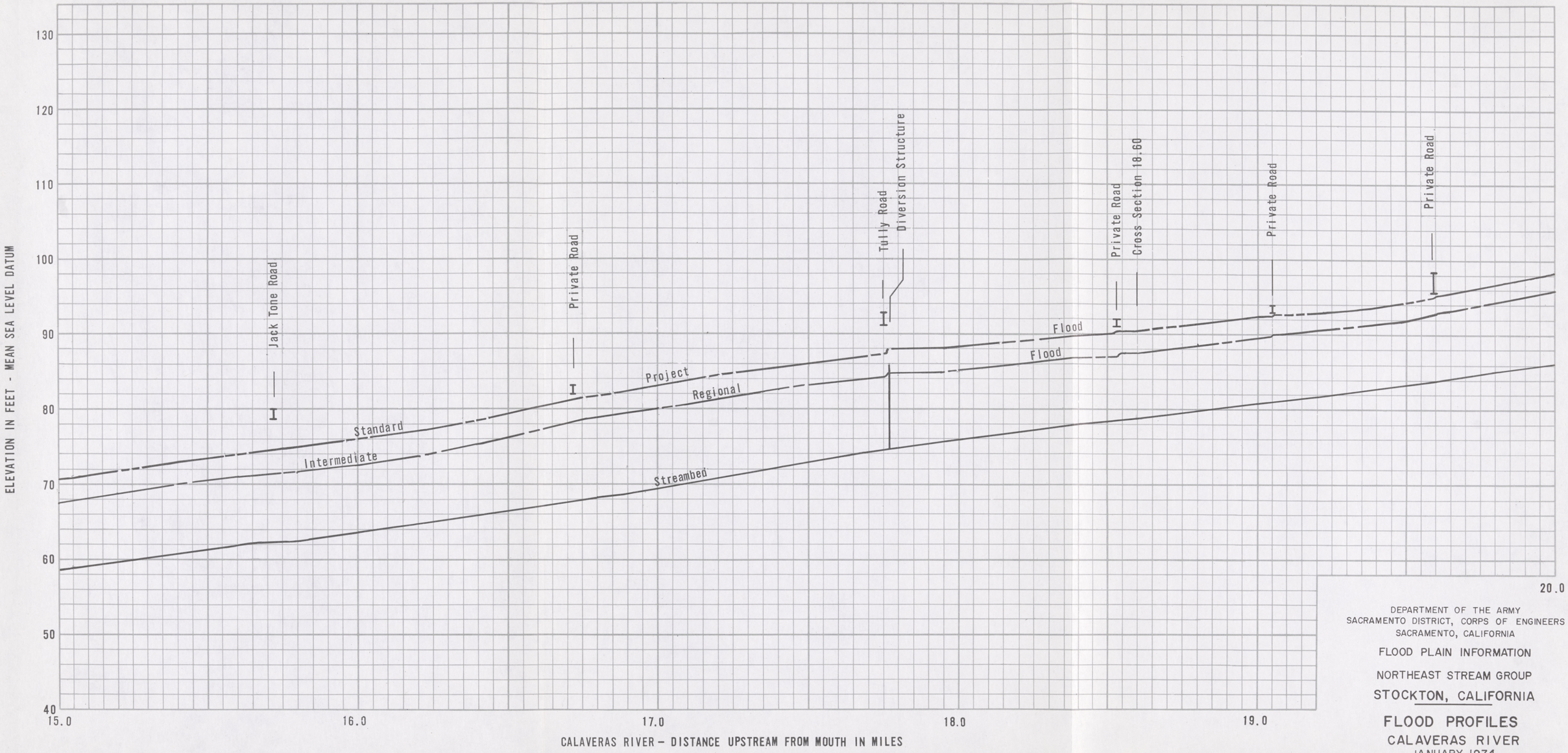
JANUARY 1974

PLATE 25



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOOD PROFILES

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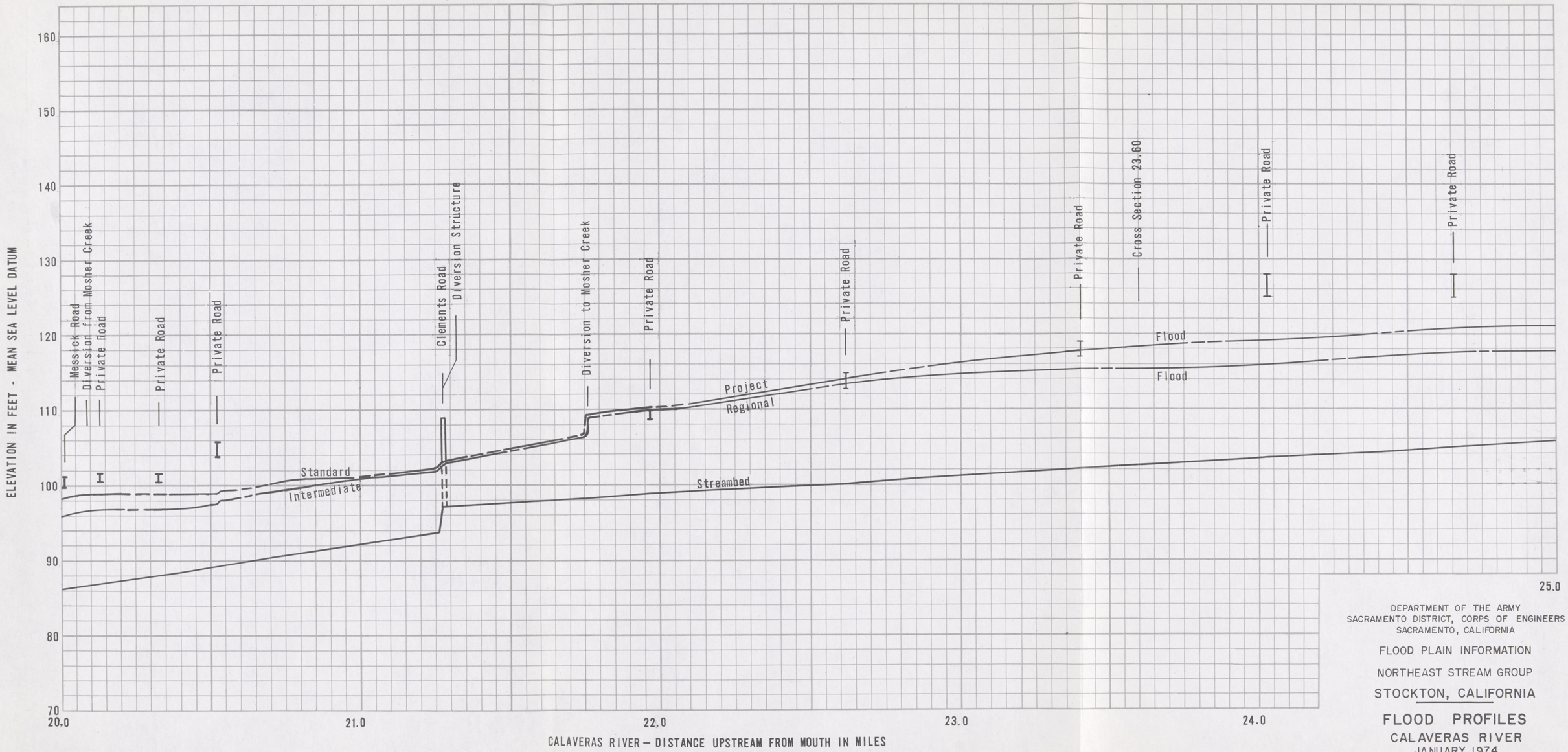
JANUARY 1974

PLATE 26



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

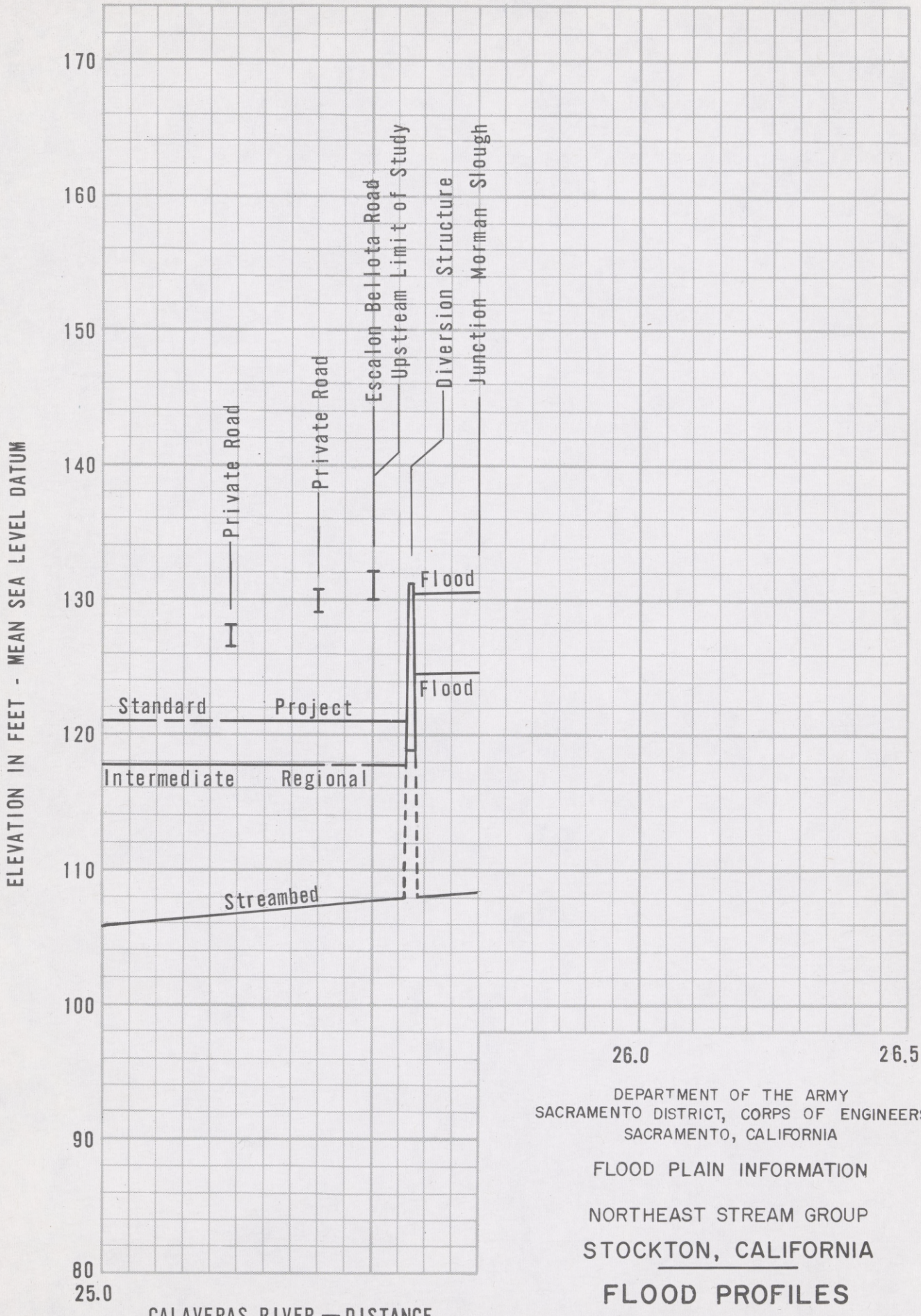
STOCKTON, CALIFORNIA

FLOOD PROFILES

CALAVERAS RIVER

JANUARY 1974

PLATE 27



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

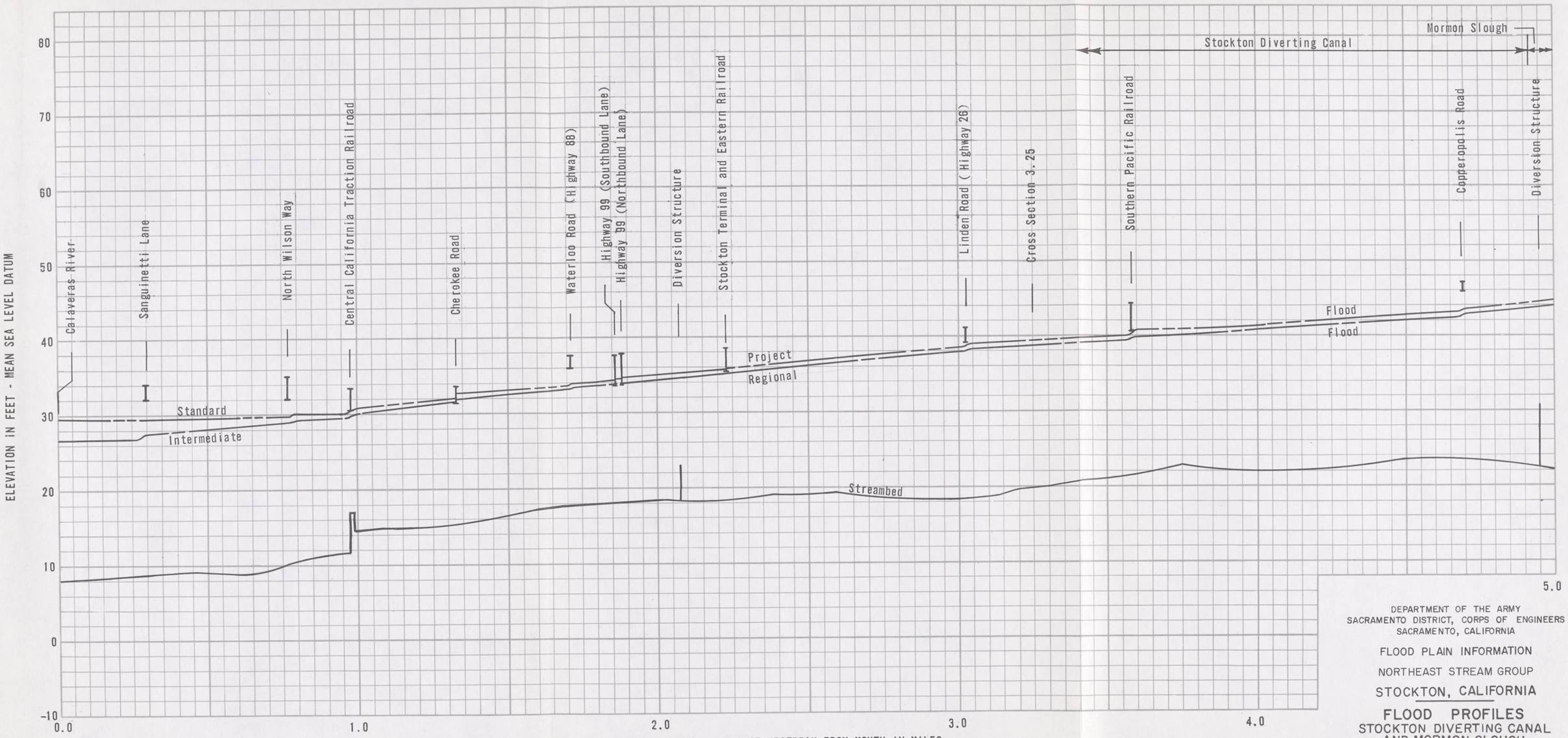
STOCKTON, CALIFORNIA

FLOOD PROFILES

CALAVERAS RIVER

JANUARY 1974

PLATE 28



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

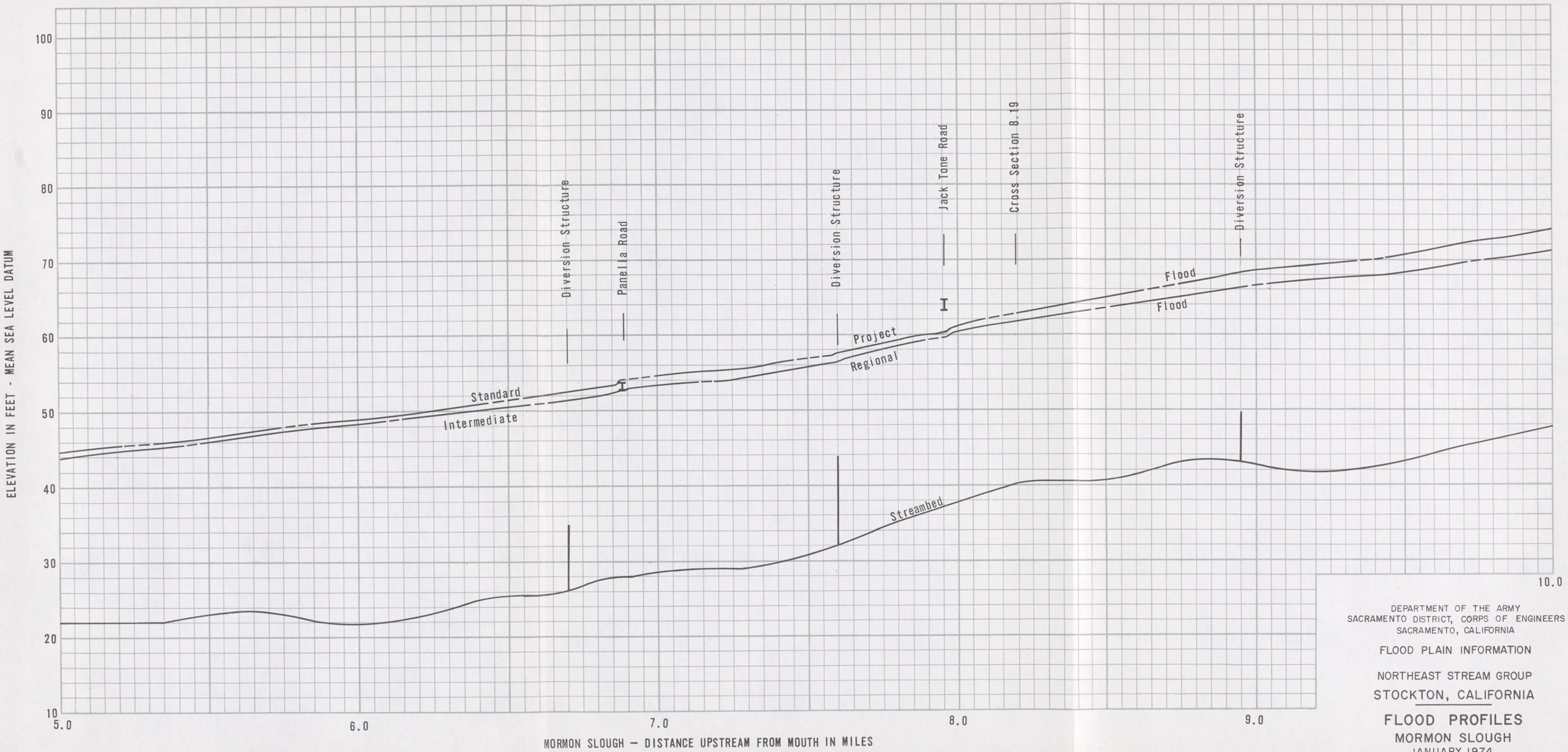
FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

FLOOD PROFILES
STOCKTON DIVERTING CANAL
AND MORMON SLOUGH
JANUARY 1974

PLATE 29



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

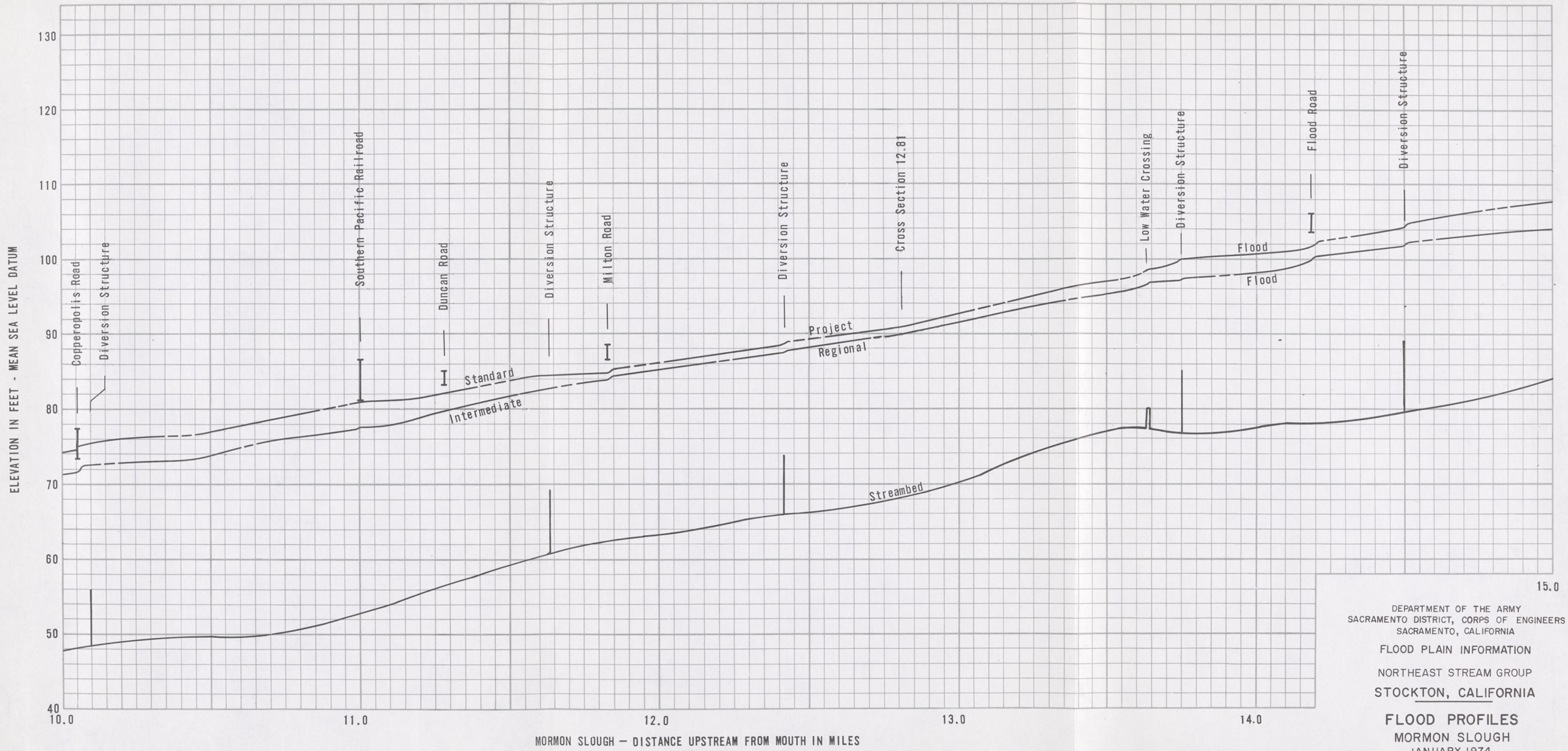
STOCKTON, CALIFORNIA

FLOOD PROFILES

MORMON SLOUGH

JANUARY 1974

PLATE 30



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

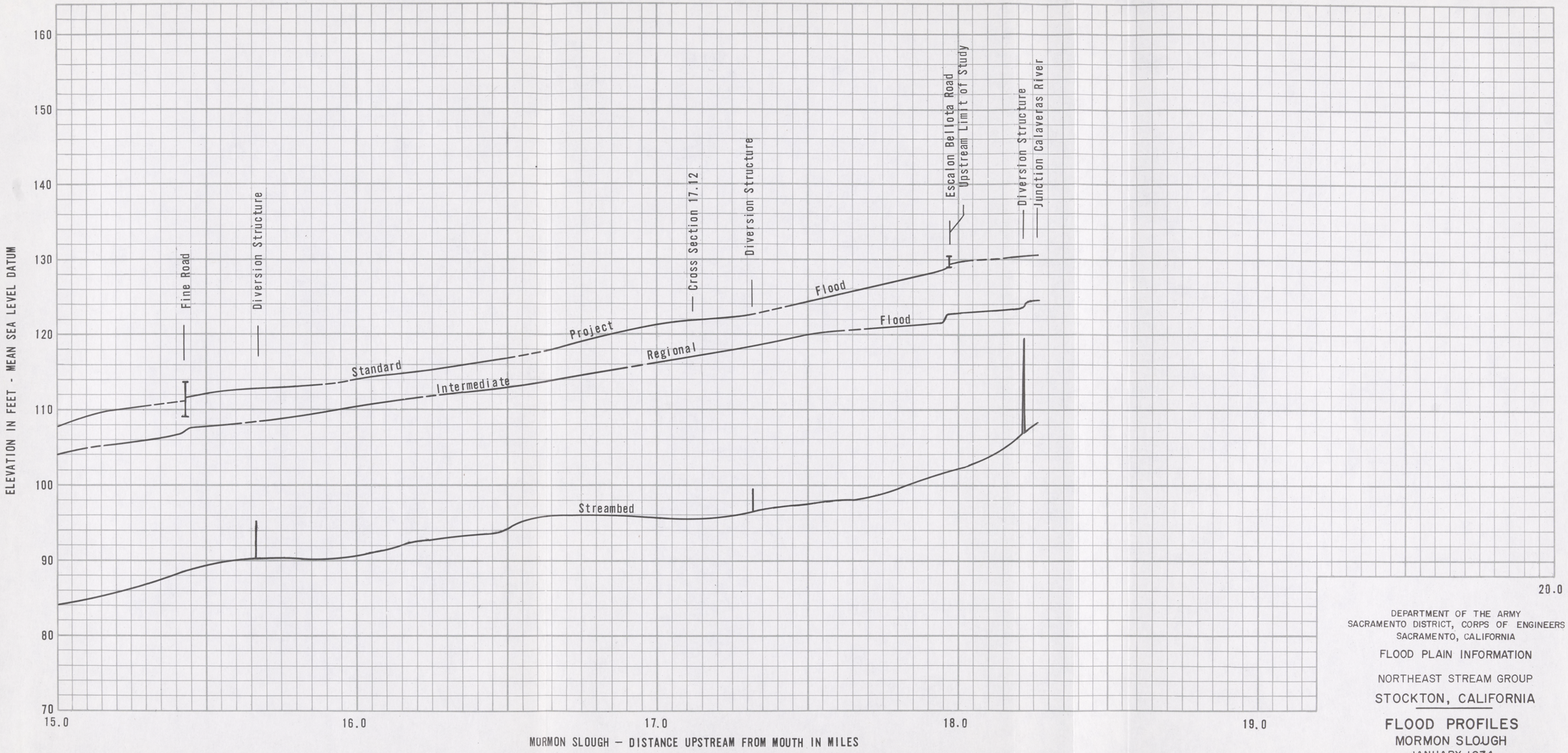
STOCKTON, CALIFORNIA

FLOOD PROFILES

MORMON SLOUGH

JANUARY 1974

PLATE 31



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

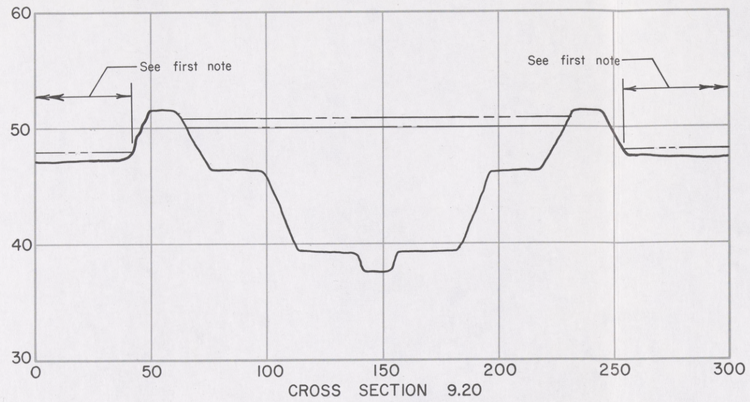
STOCKTON, CALIFORNIA

FLOOD PROFILES

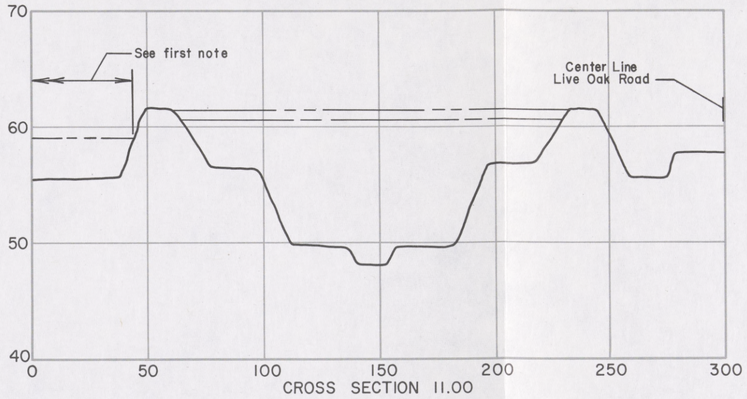
MORMON SLOUGH

JANUARY 1974

PLATE 32



CROSS SECTION 9.20



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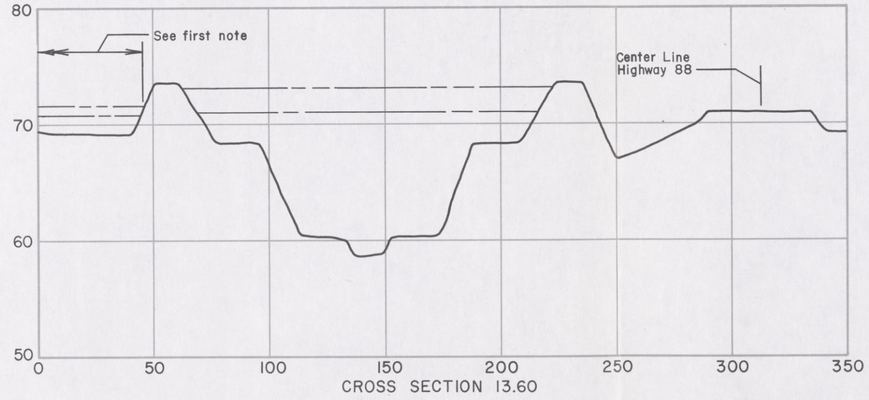
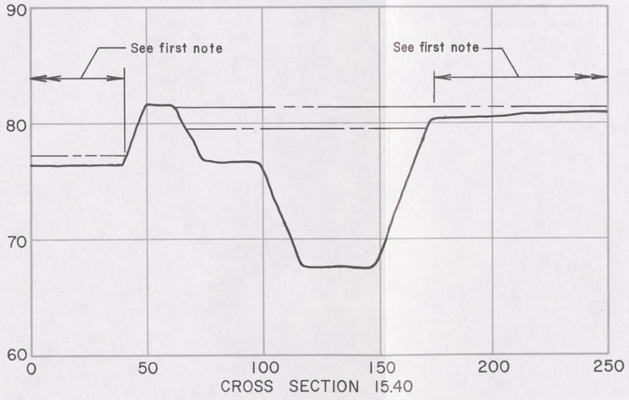


CROSS SECTION 13.60



CROSS SECTION 15.40

ELEVATION IN FEET–MEAN SEA LEVEL DATUM

LEGEND

Standard Project Flood

Intermediate Regional Flood

Approximate Ground Line

NOTES

Cross sections through sheet flow and ponding areas do not extend to the full width of the flood areas. See the Flooded Areas plates for the sheet flow area limits.

Cross sections are viewed in the direction of flow.

All horizontal distances are in feet.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

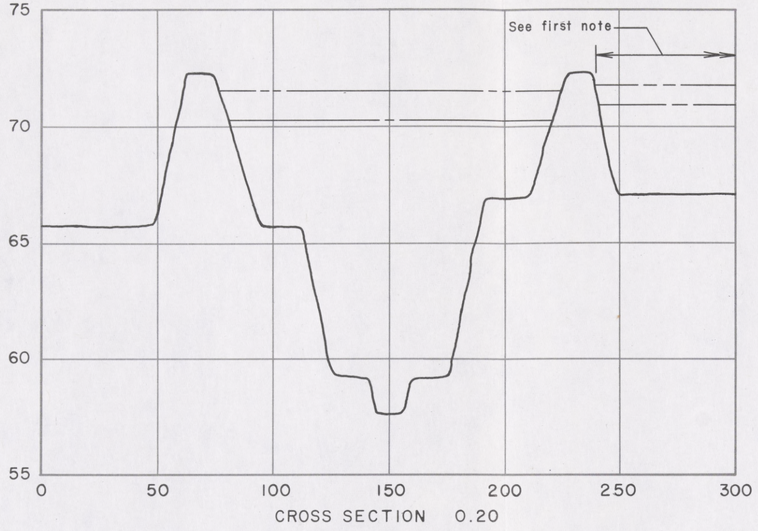
STOCKTON, CALIFORNIA

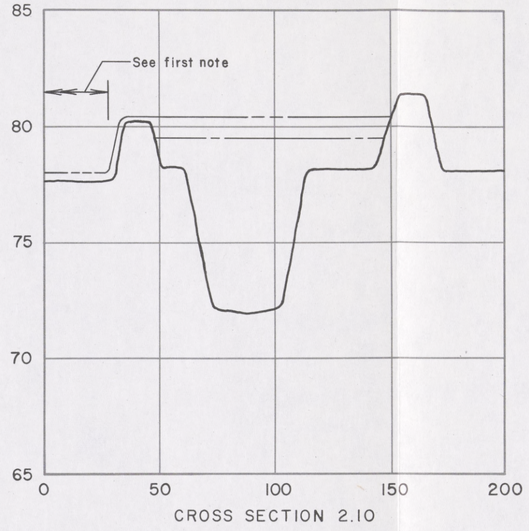
CROSS SECTIONS

BEAR CREEK

JANUARY 1974

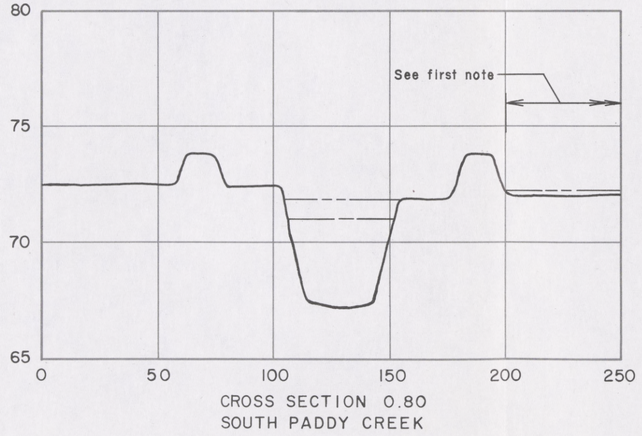
PLATE 33

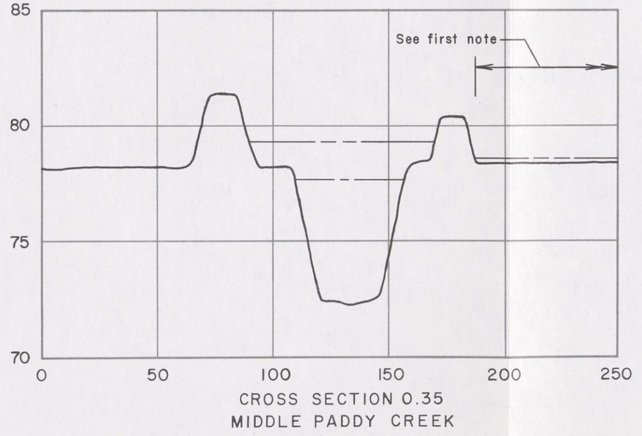




PADDY CREEK

ELEVATION IN FEET-MEAN SEA LEVEL DATUM





LEGEND

Standard Project Flood

Intermediate Regional Flood

Approximate Ground Line

NOTES

Cross sections through sheet flow and ponding areas do not extend to the full width of the flood areas. See the Flooded Areas plates for the sheet flow area limits.

Cross sections are viewed in the direction of flow.

All horizontal distances are in feet.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

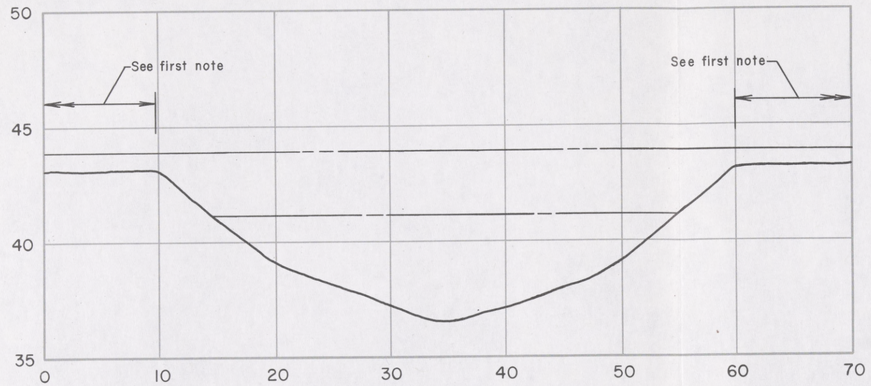
STOCKTON, CALIFORNIA

CROSS SECTIONS

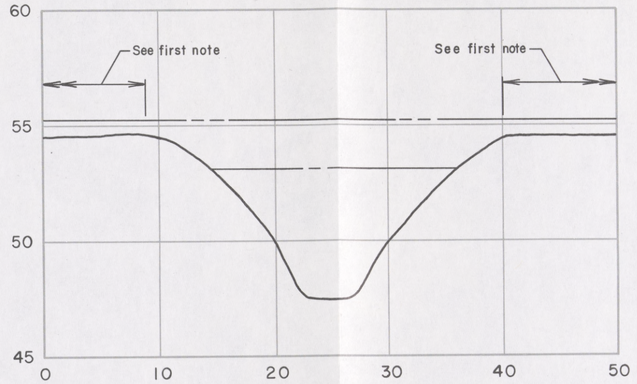
PADDY, SOUTH PADDY
AND MIDDLE PADDY CREEKS
JANUARY 1974

PLATE 34

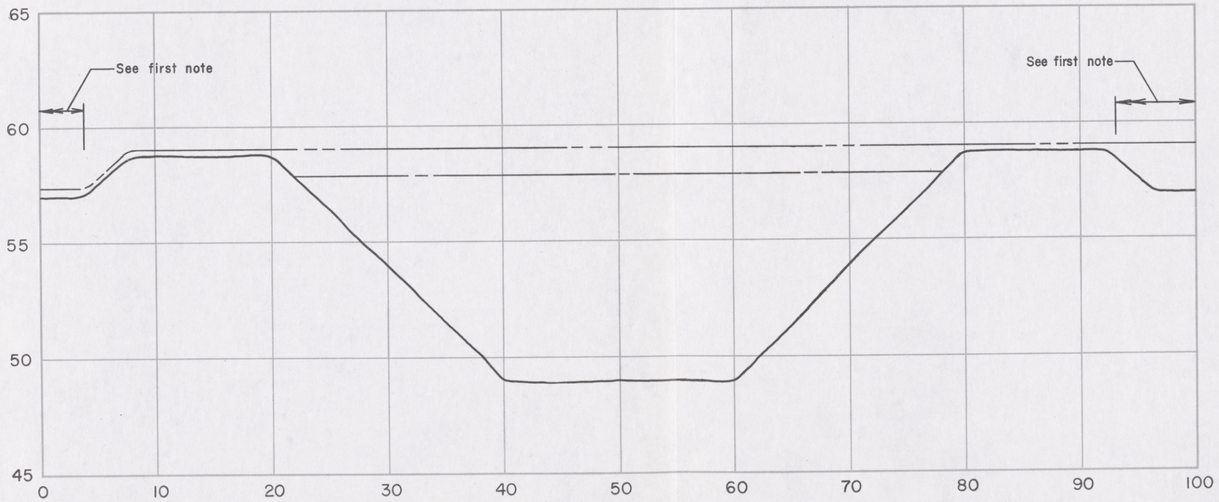
ELEVATION IN FEET-MEAN SEA LEVEL DATUM



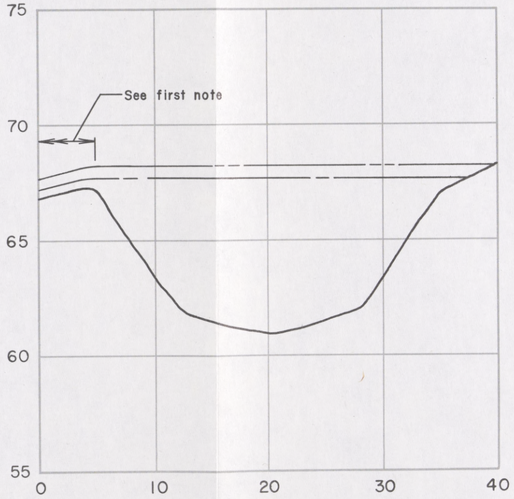
CROSS SECTION 9.80
LOWER MOSHER CREEK



CROSS SECTION 12.20
LOWER MOSHER CREEK



CROSS SECTION 0.60
MOSHER CREEK DIVERSION



CROSS SECTION 2.60
MOSHER CREEK

LEGEND

- Standard Project Flood
- Intermediate Regional Flood
- Approximate Ground Line

NOTES

Cross sections through sheet flow and ponding areas do not extend to the full width of the flood areas. See the Flooded Areas plates for the sheet flow area limits.

Cross sections are viewed in the direction of flow.

All horizontal distances are in feet.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

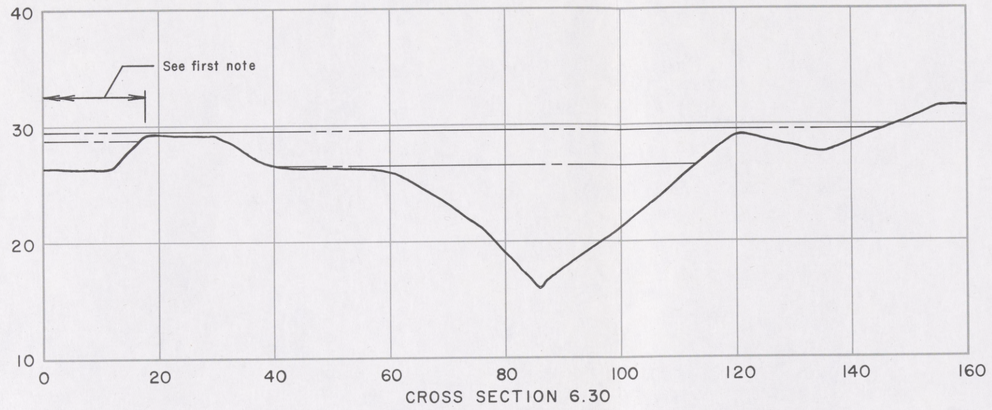
STOCKTON, CALIFORNIA

CROSS SECTIONS

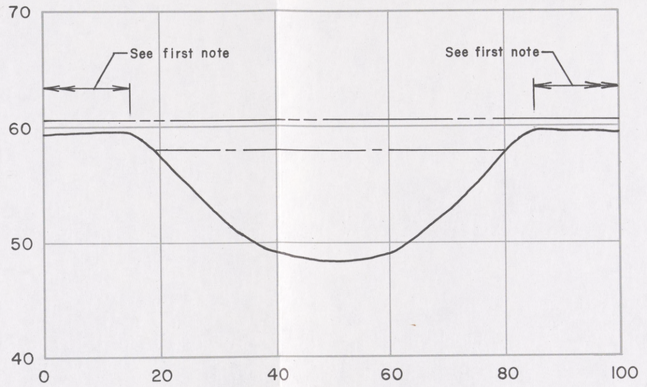
LOWER MOSHER CREEK,
MOSHER CREEK DIVERSION,
AND MOSHER CREEK

JANUARY 1974

PLATE 35

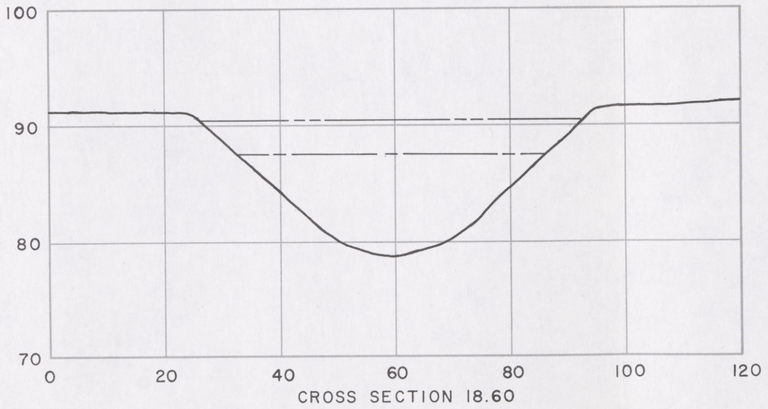


CROSS SECTION 6.30

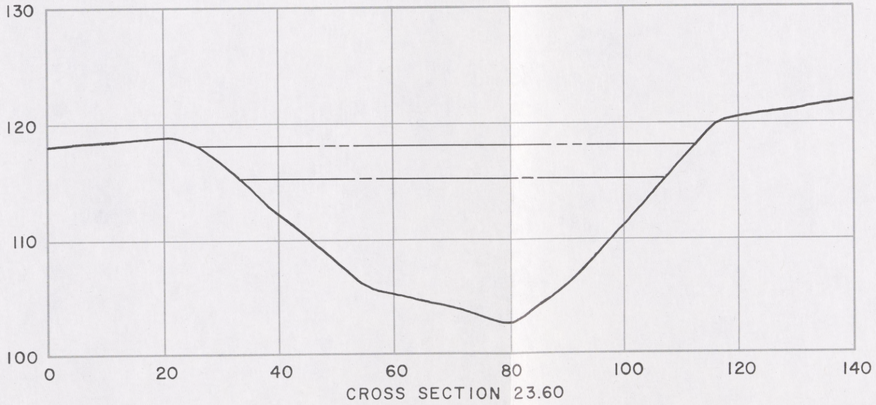


CROSS SECTION 12.60

ELEVATION IN FEET-MEAN SEA LEVEL DATUM



CROSS SECTION 18.60



CROSS SECTION 23.60

LEGEND

- Standard Project Flood
- Intermediate Regional Flood
- Approximate Ground Line

NOTES

Cross sections through sheet flow and ponding areas do not extend to the full width of the flood areas. See the Flooded Areas plates for the sheet flow area limits.

Cross sections are viewed in the direction of flow.

All horizontal distances are in feet.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

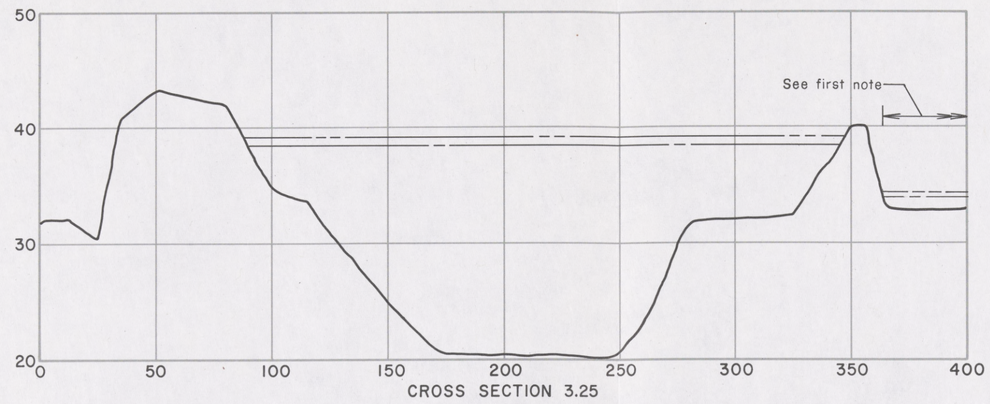
STOCKTON, CALIFORNIA

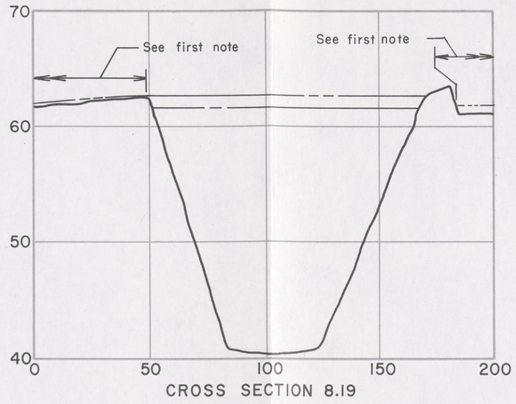
CROSS SECTIONS

CALAVERAS RIVER

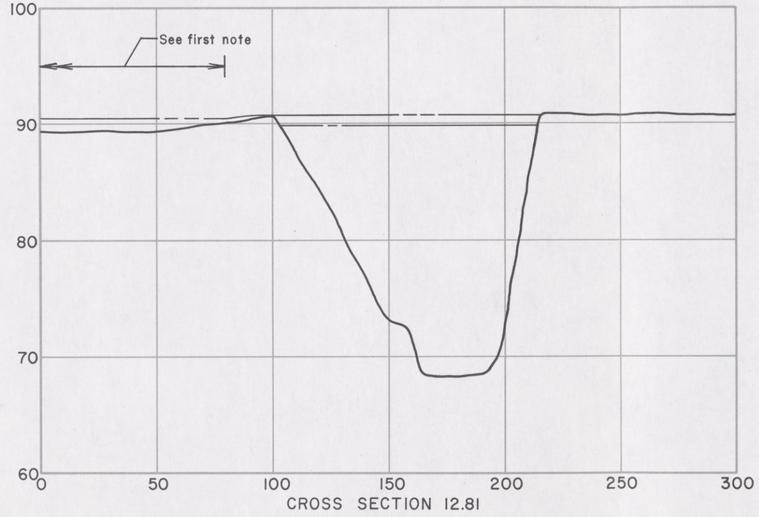
JANUARY 1974

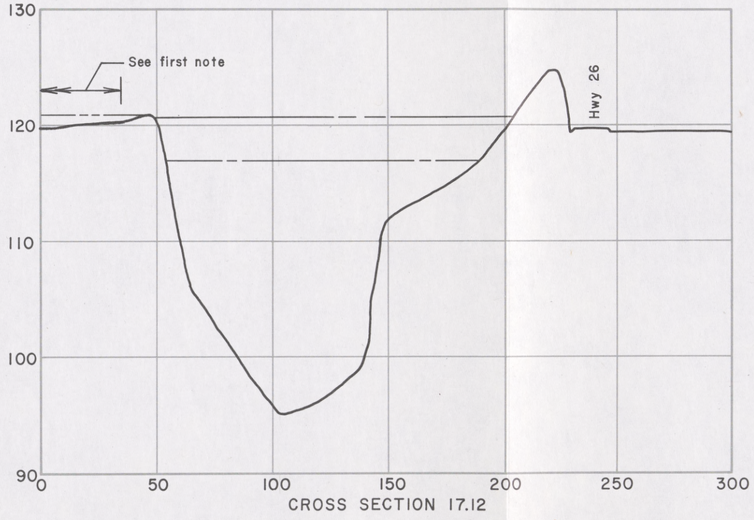
PLATE 36





ELEVATION IN FEET- MEAN SEA LEVEL DATUM





MORMON SLOUGH

LEGEND

- Standard Project Flood
- Intermediate Regional Flood
- Approximate Ground Line

NOTES

Cross sections through sheet flow and ponding areas do not extend to the full width of the flooded areas. See the Flooded Areas plates for the sheet flow area limits.

Cross sections are viewed in the direction of flow.

All horizontal distances are in feet.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

FLOOD PLAIN INFORMATION

NORTHEAST STREAM GROUP

STOCKTON, CALIFORNIA

CROSS SECTIONS

STOCKTON DIVERTING CANAL
AND MORMON SLOUGH
JANUARY 1974

PLATE 37

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT